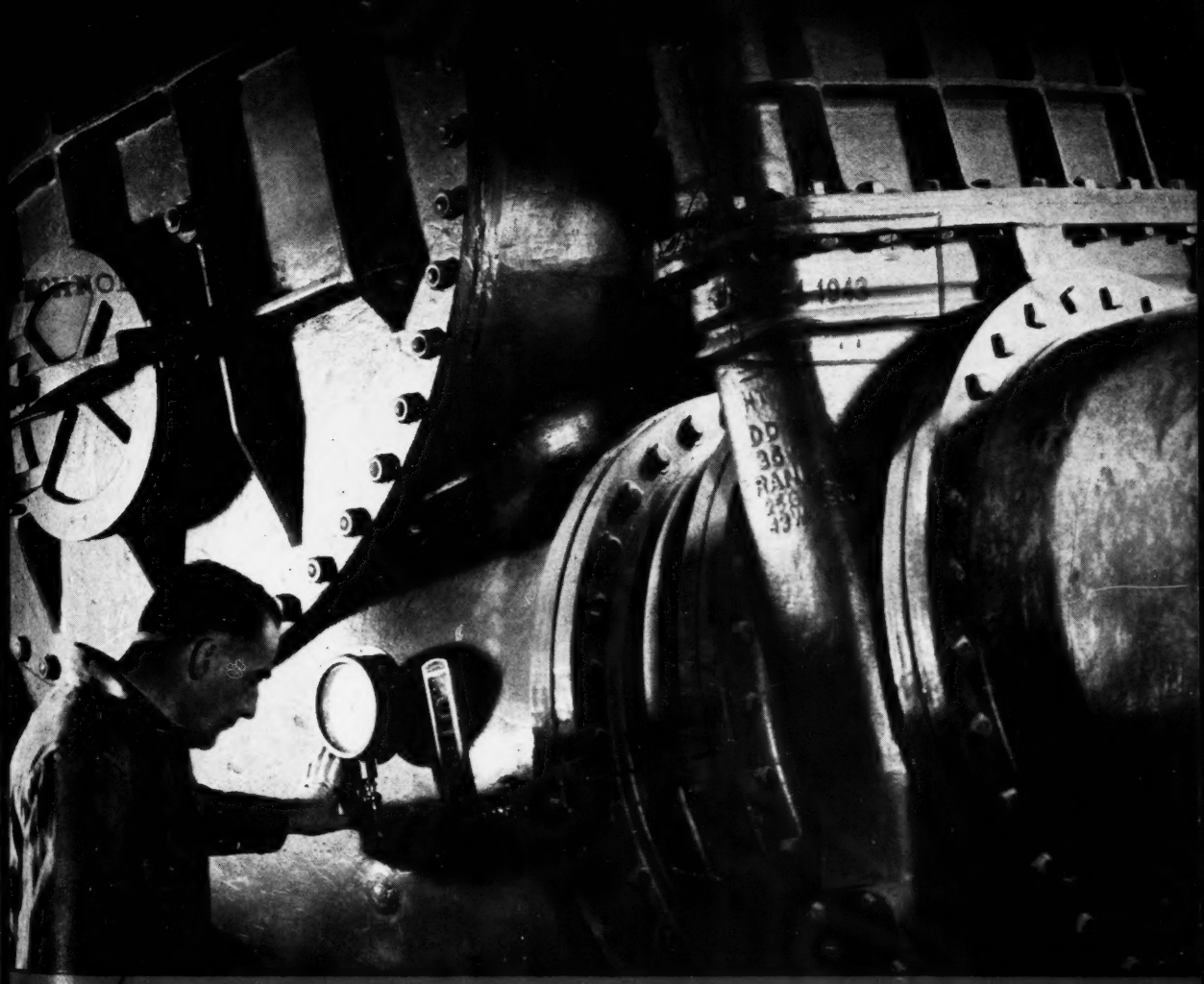
POWER PLANT ENGINEERING

THE POWER ENGINEERING AND MAINTENANCE MAGAZINE FOR EVERY INDUSTRY



HARBOR STEAM PLANT, LOS ANGELES

Conversion From Oil To Coal • Keep Them Pumping

Results From Acid Regenerated Zeolites

New Equipment Trends • Circulation This Issue—20,300

JUNE 1943

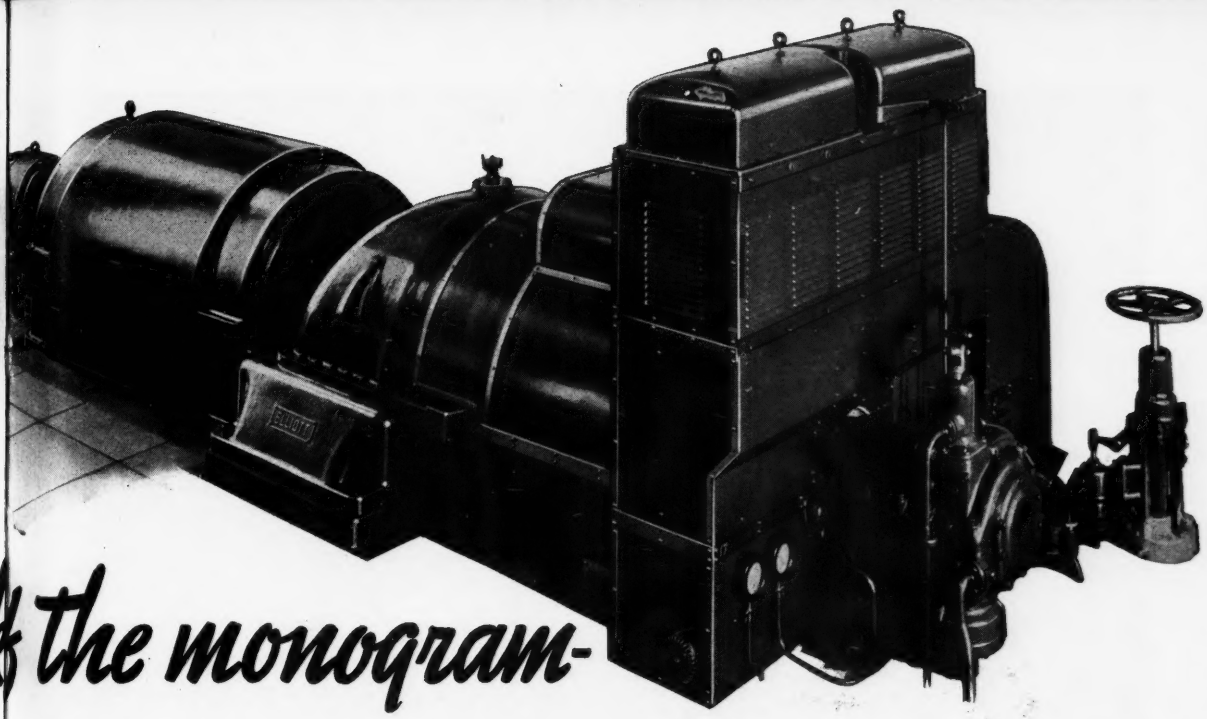
ELLIOTT MECHANICAL DRIVE TURBINES are in use by thousands in refineries, process plants, power plants. The photo shows an Elliott turbine-blower unit widely used in war production processes. The blower is also built by Elliott.

ELLIOTT TURBINE-GENERATORS are serving in hundreds of central station and industrial power plants. The entire unit is Elliott-built.

What's back t

A MARK OF AMERICAN INDUSTRY AT ITS BEST

ELLIOTT



ck the monogram- in TURBINES!

The answer is, *DEPENDABLE POWER* — smooth, quiet, economical, reliable POWER which today is turning many of the wheels of war production. Power not only to make kilowatts, but also to drive blowers used in producing explosives, and synthetic rubber materials; to drive pumps for the production of the high octane gasoline our flyers are using so splendidly; to drive a variety of equipment which is bringing Victory nearer day by day.

The engineering background of Elliott turbines goes back to the beginning of the century. The progenitors of today's Elliott turbines first took shape almost forty years ago. Even then they were good units—some of these earlier turbines being rebuilt only recently, after a third of a century in service.

Elliott turbines today have advanced to their present standard of excellence through a process of conservative development. The result is turbines that can "take it," as they are doing in some of the toughest, most trying drive jobs there are.

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The Army-Navy E has been awarded to both the Jeannette and the Ridgway plants of Elliott Company.

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Texaco Regal Oils rapidly free themselves from air and water, and highly resist oxidation and emulsification. They keep lubricating systems free from harmful gum and sludge deposits, assuring normal bearing temperatures . . . and governors instantly responsive to every load-change.

So effective have Texaco Lubricants proved that they are definitely preferred in many other important fields, a few of which are listed in the panel.

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☆ ☆ ☆

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TEXACO Regal Oils
FOR ALL TURBINES

TUNE IN FRED ALLEN EVERY SUNDAY NIGHT—CBS ★ HELP WIN THE WAR BY RETURNING EMPTY DRUMS PROMPTLY

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F&E

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✓ *Efficient,*
✓ *Economical*

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The "F&E" name plate on an "F&E" Underfeed Stoker signifies the capability of that stoker to carry on a 25-year reputation for outstanding stoker performance. For here at "F&E" we are justly proud of the performance records "F&E" Stokers have made in hundreds upon hundreds of all types of power plants. They are the result of sound stoker design and engineering, precision workmanship, quality materials and capable engineering.

To heating and power engineers, the "F&E" name plate has become a symbol that represents satisfaction of their most exacting specifications.

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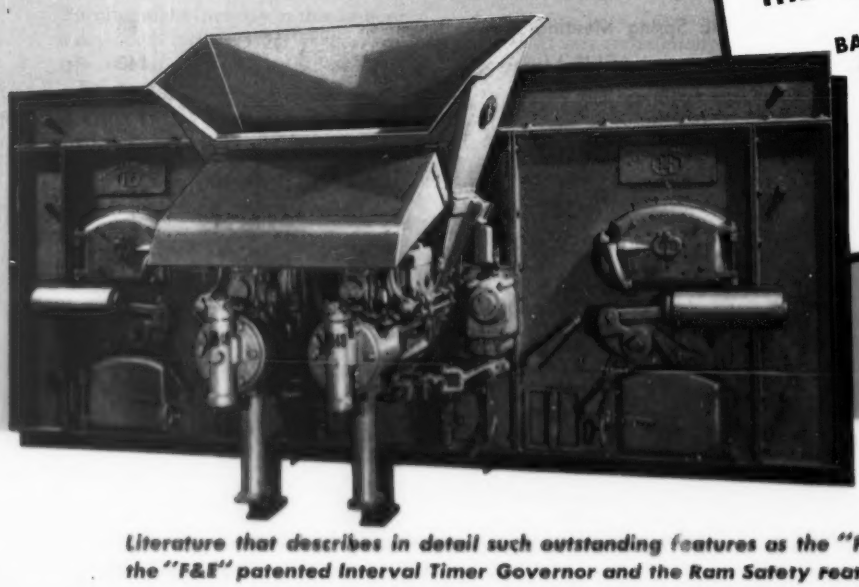
"F&E" Stokers are available in Anthracite or Bituminous Types, with Electro-Hydraulic or Steam Drive . . . . for heating or power boilers requiring 1,000 to 40,000 lbs. of steam per hour.



Illustrated is the "F&E" Series 70 Heavy Duty, Double Retort, Underfeed Stoker with Electro Hydraulic Drive, Moving Grates and Power Ash Dumps.

Literature that describes in detail such outstanding features as the "F&E" Electro-Hydraulic Drive, the "F&E" patented Interval Timer Governor and the Ram Safety feature is available upon request.

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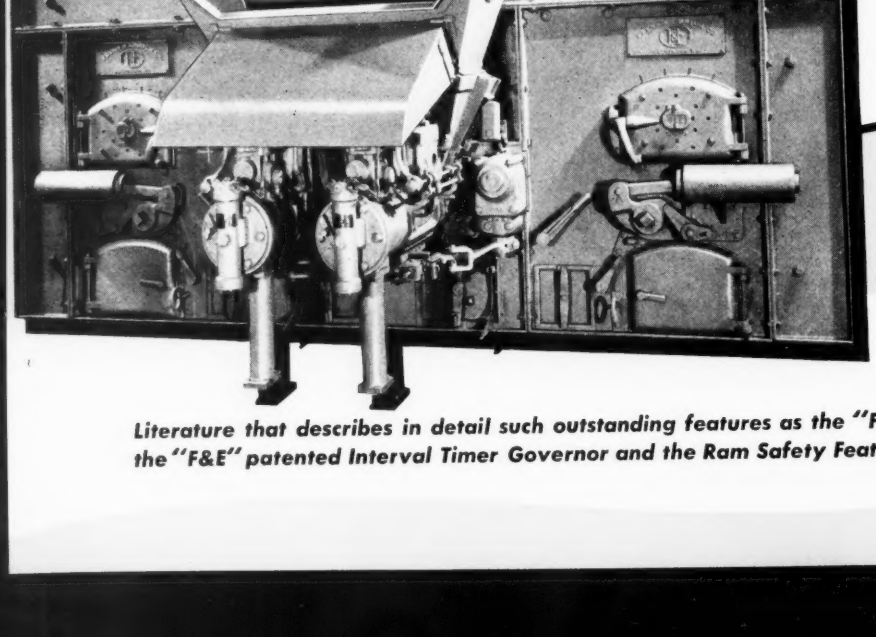

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MORE METALS will be used in the future because their partnership with plastics will make possible many new products, according to Dr. A. Allan Bates of the Westinghouse Research Laboratories. In some cases the two will cross bats as rivals until the better one wins out. But despite the contention of some partisans who claim that plastics and synthetic resins eventually will be used for everything except food, there are innumerable articles that will be metal for years to come. Among them are automobile crankshafts and valves, electric transmission lines, electric motor armatures and many other things that require conductivity and stability at very high temperatures. Plastics have esthetic appeal, corrosion resistance, lightness with strength, and other important engineering properties. They can be made from such abundant raw materials as coal, air, water, wood and cotton. The cost factor, however, still gives metals the advantage in many cases. Various plastics cost from about 20 cents to $1 a pound while steel can be produced for several cents a pound, copper at 12 cents and aluminum at 15 cents. The economic advantage held by some metals may diminish in the most distant future as high-grade ores are worked out and we have to process progressively lower grades.

LUMINOUS bacteria that glow in the dark have been recruited by science to help protect war workers from contagious ills. A harmless form of bacteria that is luminous is used to determine exactly how much ultraviolet radiation from Sterilamps is needed under varying conditions to kill germs before they can travel short distances in the air. Many of the common diseases are passed from one person to another when germs get into the air by a cough or sneeze or even normal breathing. The Sterilamp is the slender rod-shaped tube, developed for practical use in Westinghouse laboratories, which emits ultraviolet rays deadly to air-borne bacteria and viruses.

TO ENCOURAGE the burning of used and refined lubricating oil, which may be used as a substitute for the heavy types of fuel oil in industrial heating and processing, the Office of Price Administration has exempted this product from the fuel oil rationing regulations. Used lubricating oil, such as crankcase oil drained from gasoline engines, can be burned in place of No. 5 and Bunker "C" fuel oil in furnaces designed to use these heavy fuel oils, after it has been filtered and heated to remove foreign particles and gasoline.

INDUSTRIAL data sheets giving compilations of material on safety, out of the experience of hundreds of industrial companies in the United States and Canada, are available from the National Safety Council, 20 North Wacker Drive, Chicago. These data sheets cover everything from acetic acid to zinc and zinc oxide, including, by the way, black widow spiders, heat cramps and the use of salt, handling of dry ice, and so on .

TO PROMOTE the use of safety devices and equipment despite limitation orders on critical materials recently issued by WPB, the Division of Labor Standards of the U. S. Department of Labor urges the development of war emergency revisions of standards and specifications to permit the use of non-critical materials wherever possible. Complete details on what can be done may be obtained from the Division of Labor Standards, Washington, D. C.

A BABY STEEL MILL that turns out ingots weighing only 13 lb is playing an important part in America's expanding warplane program. Howard Scott and William Johnson, Westinghouse research metallurgists, used the mill to replace a thermometer manufacturer's dwindling supply of Kovar and avert a threatened break in production of temperature gages for bomber and fighter planes. Made in large batches in regular Westinghouse production furnaces, the resistance properties of Kovar are ordinarily not important. But to the thermometer concern, the resistance of the alloy, particularly the way the resistance increases as the metal gets hotter, was vital. As war demands depleted the manufacturer's original supply of wire, he sought more that would resist the electric current at precisely the same rate. Within a few weeks, the two metallurgists sent four suitable Kovar ingots to the thermometer plant. Each one was the result of painstaking measurement of the alloy ingredients and careful cooking of the mixture in a tiny electric furnace. After each ingot was cooled and forged into a rod, samples from it were closely checked for resistance values in the laboratory. By making minute changes in the ingredients and in the melting process, the research men produced an exact duplicate of the original Kovar supply; thus the plane thermometer output can keep pace with the air forces' demands.

WHEN the heavy casualty lists begin to roll in, as soon they will, what kind of impressions, asks Printers' Ink, will current advertising make upon stricken mothers, fathers and wives? How will bereaved families like to be told that a given cosmetic product is "vital" to victorious civilian morale? How will they react to claims that a trade-marked article of sports attire "can take it like a Commando"? What will be the measure of their enthusiasm for glib intimations that some confection is a weapon of war?

SALVAGING machine tool cutters may be absolutely necessary in a great many plants these days. A great deal of valuable information on how to do it will be found in the February, 1943, issue of Grits and Grinds published by the Norton Co. Detailed instructions with illustrations are given for such operations as: salvaging an end mill with broken tooth; reclaiming a worn out counterbore or worn out milling saw; making a counterbore out of a drill worn down to the discarding limit.

THEFT AND FORGERY of U. S. Government checks and activities of the petty mail box thief are rapidly increasing, warns the U. S. Secret Service, because of the greatly increased number of Government checks issued at this time. This may work great hardship on the rightful payee because it takes six to twelve months under present conditions to receive a duplicate check and meantime the service man's dependents may be without much needed funds. Every business establishment, therefore, is urged to use the greatest care in cashing such checks, especially soldiers and sailors allowance and allotment checks. For safety, the payee should cash Government checks at the same place if possible. The two best means of identification, says the Secret Service, are the draft registration and classification cards for men and ration cards and books for women, provided there is no possibility that the names have been changed on these documents. Your nearest U. S. Secret Service office or Thomas J. Callaghan, supervising agent, U. S. Secret Service, Chicago, Ill., will give you details.

WHAT LEADERS SAY

Engineering "Know-How" at War

By ALFRED P. SLOAN, Jr.

APPLICATION to the war production effort of all the skill and management "know-how" acquired by General Motors through many years of manufacturing experience is resulting in the conservation of thousands of tons of critical materials, in important savings in man hours (thus releasing men and machines for further vital work), in sharply reduced costs, in the organization of new methods in maintenance and service, and in substantial contributions to an advancing military technology.

Production rates have been accelerated, engines have been increased in horsepower, guns have been simplified and given longer life, and improvements have been made in tank construction, in airplane propeller design and in the manufacture of shells. New devices have been developed, new characteristics built into old devices. Meanwhile, a sound basis has been established for continued advance in war production techniques.

In past years, the energies of American industry were focused on the development of a peacetime technology for the production of civilian goods; there was very little demand for war materials. Consequently, there had not been developed techniques for the intensive mass production of war materials that is now required. What is taking place is the application of management skill and experience, gained from peacetime production for consumers, to the problems of turning out vitally-needed implements of war. This, together with the application of newly-developed methods, is creating a new technology of war production."

Without the generous cooperation of other manufacturers and of Army and Navy technicians, much of this progress would not have been possible. Mass production begins with planning, involves the attainment of complete interchangeability of parts and, finally, requires the introduction of progressive processing and assembly. In the case of one type of machine gun, it became possible through changes in manufacturing methods to double production in the same man hours, to cut costs to half the original amount and to build additional quality into the gun. Through new processes, more plentiful materials were substituted for critical materials; the number of special types of steels required was reduced by two-thirds.

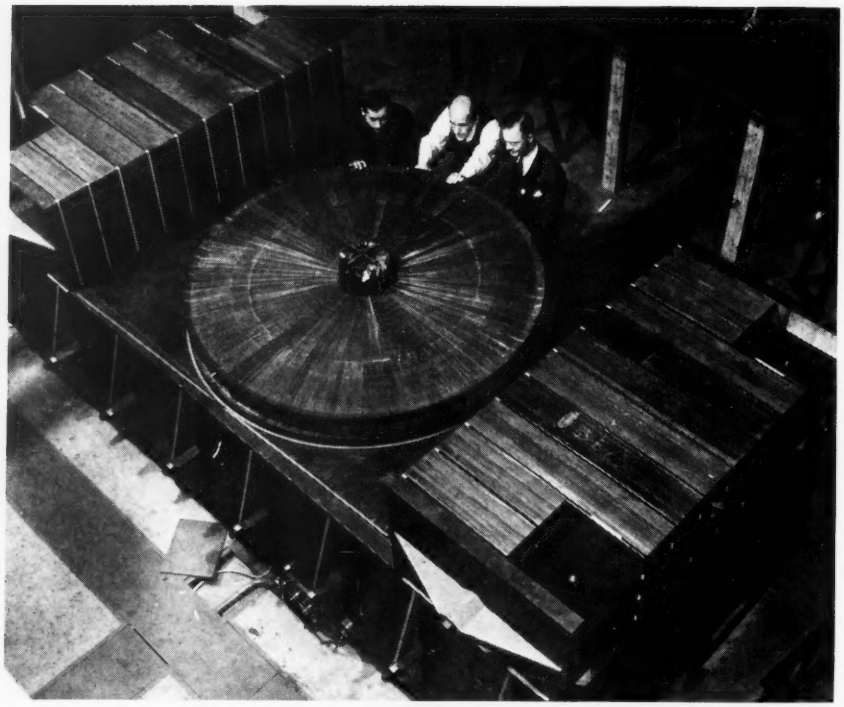
Cooperation with machine tool manufacturers resulted in the development of new machines which greatly shorten manufacturing time, releasing operators and tools for other assignments. For example, side plates originally milled individually were pressed nine at a time. This process was later improved by stamping the plates on a punch press, using five men for the operation instead of 40, thus enabling one division to transfer 35 men to other vital operations. Vertical reamers and drilling machines now handle up to 12 gun barrels at one time. Electric riveting, replacing the conventional cold hammer method, halves the production time on the riveting operation while doing a much more satisfactory job. Beyond the problem of production itself is that of maintaining equipment in satisfactory operating condition on the fighting fronts. To this end our facilities and experience have been placed at the disposal of the military authorities for the training of Army and Navy personnel, for the planning for adequate supplies of parts and for the establishment of maintenance and repair depots in the combat areas. For many months the corporation and its divisions have conducted a series of schools for training technicians and instructors in the Services, who become operating specialists or, in turn, conduct technical classes for the men in the armed forces.

The experience of many years in providing parts for automobiles and other peacetime products for world-wide markets has enabled the corporation to make suggestions as to required parts supply which have saved time, shipping space and millions of dollars worth of critical materials. Service and maintenance experts likewise are cooperating with the technical officers of the armed forces to help keep war products operating at highest efficiency wherever they may be used on the widely scattered fronts. The final proving ground for military equipment is the fighting fronts. It is, therefore, of the greatest importance that facts as to the results achieved with such equipment, its performance under varying conditions, its stamina in combat, and the maintenance problems incident to keeping it at maximum effectiveness, be made available to production engineers as completely and as rapidly as possible. It thus becomes possible to establish a broader basis for progressive technological advance in military production. Modern implements of war must be specialized in order to meet specific needs. Mechanical equipment intended to perform a particular duty must be of highly intensified design in order to give maximum performance in that one special service. This means that for duties other than those for which it was designed, an item of equipment may render, in comparison, mediocre or even inferior performance. Viewed from another angle, this principle of selection is, of course, the very thing that makes possible the engineering of superlative performance in the specific area desired.

The life story of Alfred P. Sloan, Jr., chairman of General Motors Corp., parallels the development of the automobile. He has seen and been a part of it all. Hence he is in a particularly authoritative position to tell how the automobile industry has applied its skill and experience to war production.

Mr. Sloan was born in New Haven, Conn., in 1875. He was graduated from Massachusetts Institute of Technology with a B.S. degree and began work as a draftsman for Hyatt Roller Bearing Co. in Newark, N. J. His first job was helping perfect John Hyatt's mechanism for making billiard balls. He was named president of the Hyatt company in 1897 and throughout his service with that company was in contact with leaders of the automobile industry.

In 1916, he was made president of United Motors Corp. which became part of General Motors Corp. in 1918, when Mr. Sloan was named vice-president of the latter, also a member of the executive committee. In 1920 he was elected president of General Motors Corp. to succeed Pierre S. du Pont, serving in this capacity until 1937, when he was elected Chairman of the Board. In the same year, he established the Alfred P. Sloan Foundation for carrying on basic economic studies. The material presented here is taken from a recent report by Mr. Sloan to General Motors Corp. stockholders.



What! No Secondary?

WITHOUT knowing anything more about it, a "power" engineer might assume that the three men in the photograph shown above were examining the core for a large transformer. Certainly, the stacks of laminations resemble those commonly used in power transformer practice. This, however, is not going to be a transformer, at least not an ordinary transformer. Actually, it is the lower part of the huge alternating-current magnet, made of slabs of steel and spaced apart for cooling, which will provide the accelerating force in the new 100,000,000 volt X-ray generator now being built at Schenectady as an addition to the General Electric Research Laboratory. ¶ This unit will generate the most penetrating X-rays in the world, so far beyond anything in existence at present that any comparison seems absurd. The machine is called an induction electron accelerator and it will give electron energies far higher than have ever been given by a human agency before. The operation of the accelerator is similar to that of a transformer but, strangely enough, it has no secondary winding. The primary consists of two 98-in. coils of insulated copper conductor 0.88 in. in dia each coil having 40 turns and containing a ton of metal. If this machine were a transformer a secondary winding could be placed betwen the magnet poles and a current would be induced in it. ¶ An electric current, however, ordinarily consists of a flow of electrons between the atoms and molecules of a conductor. They can, however, be made to travel in space, without any conductor, and this is done in the accelerator "doughnut" a specially designed vacuum tube. The interior of this vacuum tube acts as the secondary of a transformer. Electrons emitted from a hot filament at the center of this "doughnut" proceed spirally around the interior of the tube under the action of the magnetic field. They are whirled around a quarter of a million times in 1/240th of a second and on each revolution receive a 400-v push. In traveling to the periphery of the tube, their total travel is about 800 miles, which means that their path has to be guided with extreme accuracy, in fact, it is like shooting on a curve for a distance as great as from Schenectady to Chicago and hitting a three-inch target! The electrons are speeded up during the first quarter of each cycle (60 cycle current). At the end of this quarter cycle the high energy electrons will strike a target and generate a beam of highly penetrating X-rays, which will emerge from the machine together with scattered high-speed electrons. Even these scattered electrons will be able to penetrate two inches of steel. ¶ The unit will be installed in a separate building with walls three feet thick around the machine room. The machine room will have a crane capable of lifting the 60-ton upper part of the magnet. The control room will be outside the thick wall and a periscope with four mirrors will permit the operator to watch with safety. Above the control room is the largest single bank of capacitors in the country with a total rated capacity of 24,000 kva.

WITH THE EDITORS

◆ **Psi**—Psi for "pounds per square inch" looks funny but it is handy and once you become accustomed to it, it loses its strangeness. In recent years there has been a gradual change in the use of abbreviations in engineering and technical literature mostly in the interest of greater economy and unification. Thus "lb. per sq. in." has given way to "psi" and "deg. F." has become simply "F." Not only have the abbreviations been shortened but they have been simplified by omitting periods. The period is omitted in all cases except where the omission would result in confusion.

During the past fifteen years the various engineering societies together with the Society for the Promotion of Engineering Education and in cooperation with the American Standards Association have done considerable work in the development of a standard list of abbreviations for scientific terms for use in publications. As in every effort of this kind, it has taken a long time to complete the work. The first standard was submitted for approval in 1931 but the final revision was not fully approved until March 1940. It became an American Standard in March 1941.

For many years most technical publications in this country have maintained styles and systems of abbreviations of their own making. This has been true in the case of Power Plant Engineering. With us, pounds per square inch has been "lb. per sq. in.;" Cubic feet per minute has been abbreviated "c.f.m."

Since many manuscripts reaching us these days conform to the standard referred to above and since this has caused a certain amount of confusion and inconsistency, we have decided to revise our style to conform to the system approved by the American Standards Association. Accordingly, beginning with this issue, all abbreviations will appear without periods except in cases where abbreviations result in words, such as "in." for inches. Hyphens will not appear in abbreviations except where the abbreviated word is a compound word or is used as a compound adjective, horsepower-hour (hp-hr) for example. Where we deem it necessary to use abbreviations other than those listed in the American Standard we will form our own in accordance with the fundamental rules laid down in the American Standard.

Short words such as ton, day, and mile will be spelled out. As has been our practice in the past, the same abbreviation will be used for both singular and plural, as "bbl" for barrel and barrels. Conventional signs will not be used for abbreviations in the text; thus "per," not /; "lb," not #; "in.," not ". Such signs may however be used sparingly in tabulations and on charts where it is necessary to conserve space. The letters representing societies and organizations such as ASME and AIEE will not have periods and also will not be spaced. Where an organization not very well known is referred to it will be spelled out the first time it appears in an article but thereafter the abbreviation will be used.

These are some of the general rules. Anybody wishing further information on the subject or desirous of having the complete list can get it by ordering a copy of "Abbreviations for Scientific and Engineering Terms" (Z10.1-1941) from The American Society of Mechanical Engineers, 29 West 39th St., New York City. The price is 35 cents.

◆ **King Coal**—Recently we mentioned to an industrial executive, who is fretting about the conversion of his power plant from oil firing to coal firing, that we expected to publish a very good article on this subject, Part I of which appears in this issue. "This conversion business is just ducky," he replied sardonically. "First they tell us we can't have any more fuel oil to burn and must convert to coal; now Mr. John L. Lewis tells the coal miners to stop work so we can't have any coal. What in heaven's name are we to do—go back to windmills?"

In reply we pointed out that this annual vaudeville act by Mr. Lewis and the coal miners has been on the bill for a great many years. In time of peace it does little damage. The miners have a pretty good case but it has always been presented to the general public in a very inept fashion. About all we get is a spate of Shakespearian adjectivity from Mr. Lewis—something or other is "ghastly," something else is "outrageous," still another is "malign."

But despite all his Shakespearian rhetoric, Mr. Lewis this time picks the unstrategic moment for his act. He completely underestimates its effect on public opinion in wartime, especially on the opinion of the middle class of this country, which now knows that it is fighting two barbarian enemies for its very existence. Furthermore, the miners' wages are not too bad in comparison with those of other groups. The real issues are: 1, Mr. Lewis' apparent repudiation of any responsibility to aid the war program; 2, the price control program.

In one sense Mr. Lewis has won a victory, for without any question the Administration will compromise on many points and the net result will be a wage increase for the miners. Nevertheless, the Government points out that all other parties to the dispute must deal through the War Labor Board and that Mr. Lewis cannot consider himself powerful enough to defy the authority of the agency set up by the Government for this purpose.

At this writing, Mr. Lewis, obviously in an attempt to enlist numerical support against the extremely dangerous anti-strike bill that has been introduced into the Congress and now hangs over the heads of all union labor, is now trying to lead the miners back into the A. F. of L. All this, however, is a family wrangle. Whether there is a coal strike or not, whether Mr. Lewis wins or not, coal for operating American industry will have to be produced by somebody. It is inconceivable that the Federal Government and the industries of the country can allow its basic power source to be endangered, particularly now, when oil is being considered more and more as a chemical reagent, in many cases too valuable to be used as a fuel.

It seems that industrial plants will be perfectly safe in converting from oil to coal, utilizing some of the sound, fundamental principles and the interesting engineering techniques outlined by Mr. Craig in his article in this issue.

Our present information is that some new regulations regarding conversion from oil firing to coal firing by industrial plants and utilities may be forthcoming. There is a possibility that many such conversions may even be made mandatory in the relatively near future, although the stringent regulations covering domestic heating plants may be relaxed somewhat. The industrial situation, as Mr. Craig points out, will certainly not get any better and may become worse.

Just how much coal might be saved by the "brownout" that is now being planned, possibly to go into effect July 1, is hard to estimate. Possibly WPB, if and when it puts the "brownout" into effect on a nation-wide basis, will give us its estimate of this saving.

It sums up to this, then: If you are compelled to convert from oil to coal burning you will be pretty safe, even in spite of the present threat of a coal stoppage. Coal will have to be the basic industrial fuel of the country for a long time to come. For that reason, as Mr. Craig argues, it will be well to make conversion plans on the soundest engineering basis.

◆ **Brownout**—The purpose of the nationwide "brownout" referred to above and which may be put into effect by WPB sometime in the near future is to save coal by curtailing non-essential uses of electricity, advertising display signs and decorative lighting for example. Nobody can dispute the merits of this plan, even if it may not save as much coal as some people think it will. Waste of any kind is intolerable in war and if fuel can be saved, no matter how little, by cutting off non-essential uses, it should be done.

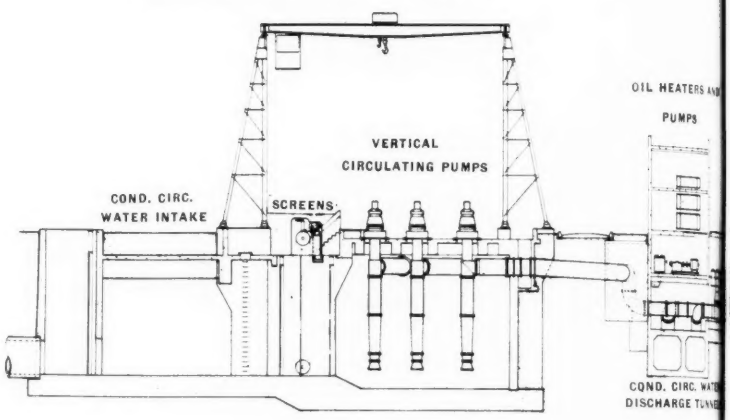
It so happens, however, that a great deal of the coal burned in this country is not used in making electricity. Much of it is used in small boiler plants for heating, for process work in industries and, of course, for generating power used in such industries. These boiler plants on the whole are considerably less efficient than those of the large central stations where a kilowatt hour is produced with less than 1.5 lb of coal on the average. True, these small plants burn comparatively little coal individually but there are a great many of them and if the efficiency of these plants could be raised by only a few per cent, the fuel saving throughout the nation would be enormous. Recently a plant of this type was directed to our attention where by simply plugging up a few leaks in the furnace and overhauling the boiler and auxiliary equipment the coal consumption was reduced from 10 tons in 12 hr to only 2 tons in 12 hr! This probably sounds incredible yet there are thousands of small plants throughout the country where most of the fuel used is wasted as it was in this plant.

We realize, of course, that no order of WPB or any other agency could raise the efficiency of these small plants but if each operator would take it upon himself as a patriotic duty to cut the losses in his plant, the amount of coal saved throughout the nation might equal that of a dozen brownouts.

Harbor Steam Plant Goes

By *Charles P. Garman*, Electrical Design Engineer
and
William C. Rowse, Steam Design Engineer
Los Angeles Bureau of Power & Light [1]

The first 65,000-kw unit of an ultimate 300,000-kw plant for the Los Angeles municipal electric power system was designed for a dual purpose: 1, to substitute for secondary energy from Boulder Dam; 2, to operate as a spinning reserve on the Boulder transmission line. A single tandem-compound turbine generator and a single oil-and-gas-fired steam-generating unit were installed to operate at 850 psi, 900 F. For quick pick-up of load from 60,000 to 500,000 lb steam an hour, boiler has large water storage space, the accumulator effect is used, boiler steam drum pressure is held constant at 1050 psi and allowed to drop to 850 psi while the turbine is assuming full load and the firing equipment increases the firing rate to full load in 20 to 25 sec. The turbine is the largest 3600-rpm condensing unit in the country. Quick load pick-up also demands control of fan speeds by a special variable-speed control. Calculated overall heat consumption at 75 per cent load is about 11,400 Btu per kw-hr. Twin main steam condensers to reduce turbine foundation height, complete automatic control, simple heat flow circuit, convenient and simple electrical design, air blast circuit breakers are features.



THE BUREAU of Power and Light of the Department of Water and Power, a municipally-owned corporation serving electrical energy within the city limits of Los Angeles, Calif., is just putting its new Harbor Steam Plant into service. The Bureau's electrical system serves 450 sq mi through six major receiving stations and is interconnected with the systems of the municipalities of Burbank, Glendale and Pasadena, of California Electric Power Co. and of Southern California Edison Co. Normally about two-thirds of the power is generated at Boulder Dam and one-third at the Bureau's local steam and hydro plants.

The Harbor Steam Plant, the first unit of which is now going into operation, has been planned for an ultimate capacity of 300,000 kw; therefore it becomes an important addition to this system.

Design of the installation of the first two units of Harbor Steam Plant was greatly influenced by the Bureau's use of Boulder power. Firm energy and secondary energy are available to the Bureau at Boulder. Firm energy in an amount fixed by contract is continuously available, therefore, neglecting for the moment transmission line outages, this requires no substitution at any time. Secondary energy, intermittently available, in an amount determined by the surplus runoff of the Colorado River that cannot be stored in Lake Mead, requires the substitution of other energy.

History of the runoff of the Colorado River indicates large quantities of secondary energy to be intermittently available about 60 per cent of the time, but at infrequent intervals of from one to five years none whatsoever to be available. Hence it was imperative that the Harbor Steam Plant, used

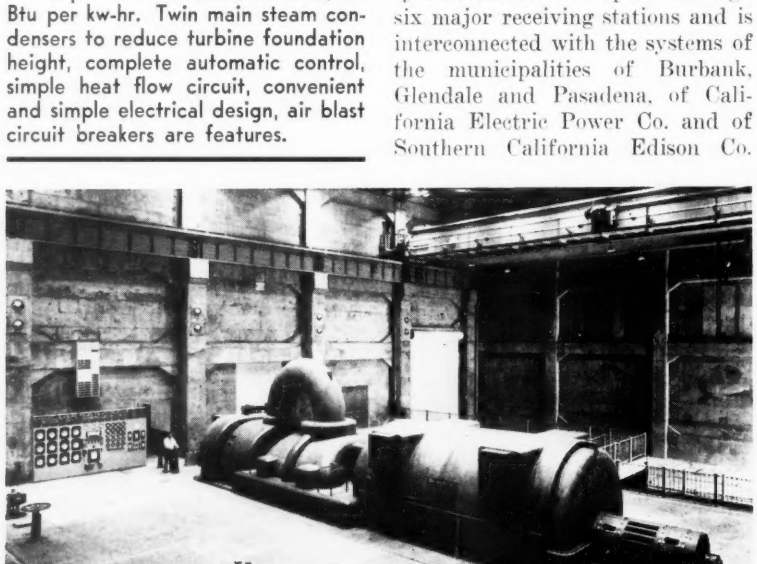


Fig. 2. View of tandem compound 3600-rpm turbine driving hydrogen-cooled, 65,000-kw generator, with turbine control panel at left

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on the Line

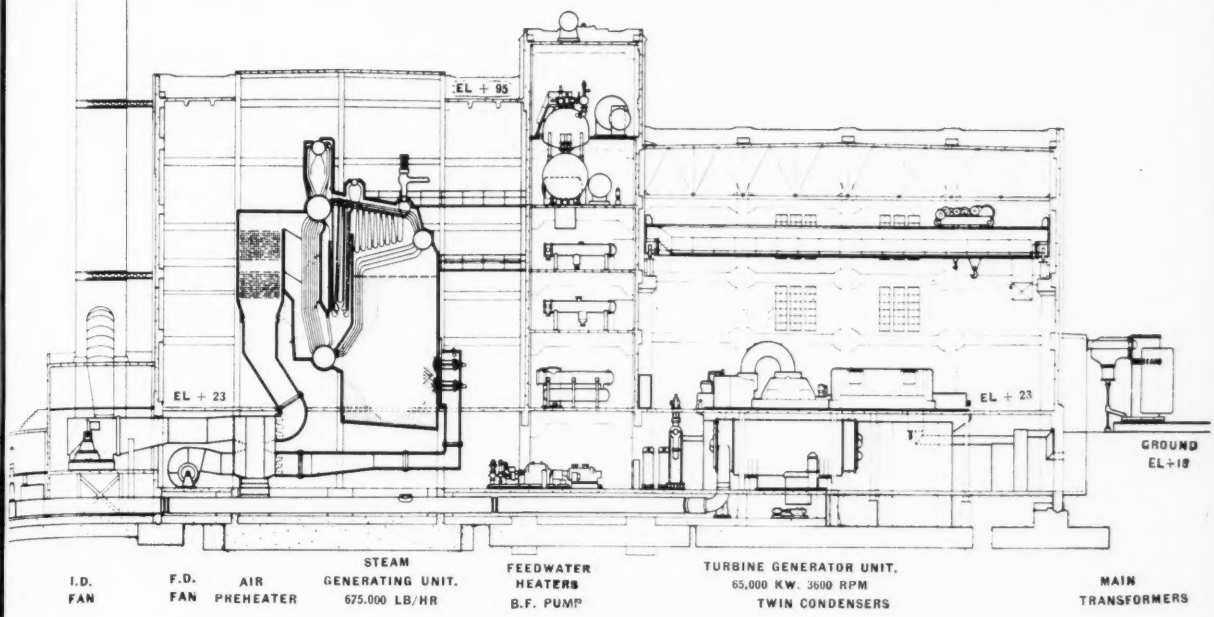


Fig. 1. General cross-section, Harbor Steam Plant, showing 65,000-kw turbine generator supplied with 850 psi 900 F by single oil-fired steam generating unit

to supply this substitute energy, be designed for good overall efficiency.

Since two-thirds of the Bureau's power requirements are transmitted, over three 287-kv circuits, a distance of 265 mi from Boulder, need for a reliable operating transmission line is obvious. When the Boulder transmission lines were designed extensive research was carried to insure this reliability.[2] However, since overhead transmission lines are exposed to other than electrical hazards, such as cloudbursts and airplane accidents, 150,000 kw of steam standby had to be provided to help stabilize the system and relieve the overload on the remaining line or equipment in case of complete loss of one double circuit tower or loss of one transformer bank. This requirement established the need for quick pick-up.

The Harbor Steam Plant, therefore, was designed to serve a dual purpose: to generate substitute energy at high load factor during periods when a shortage of secondary energy exists at Boulder; to operate as spinning reserve to the Boulder transmission lines during other periods.

Suitability of Site

Exhaustive studies were made of the suitability of the site for the Harbor Steam Plant, which is located close to the necessary large supply of condenser cooling water. These studies included construction of a model of the harbor with means for simulating the tides to obtain information on the behavior of harbor currents when pumping water.

On the basis of these studies and other considerations, it was found that: (1) the water temperature is remarkably uniform throughout the year, varying between 50 F and 75 F and averaging 60 F; (2) from chemical and biological analyses, the harbor water is not unduly corrosive; (3) most serious effects to be guarded against are the corrosive effect of free oxygen in the water and the growth of slime, or algae, on the inside surfaces of the condenser tubes; and (4) the Power Bureau would have no hesitation in constructing a steam plant on this site to have the contemplated ultimate capacity of 300,000 to 350,000 kw, or even more.

Condenser circulating water is taken from one part of Los Angeles Harbor and discharged into another part through tunnels. Based on an ultimate requirement of 500 sec ft of water and an economic velocity of 5.5 ft per sec, and allowing for marine growth on the walls of the conduits, the total cross sectional area required is 100 sq ft.

To provide this supply of circulating water, two parallel conduits were constructed from the intake structure to a screen and pump chamber at the steam plant site, a distance of 1094 ft, and to discharge the water two similar parallel conduits were constructed from the power plant site to the discharge structure in the west basin of the harbor, a distance of 1393 ft. The circulating water conduits were constructed by laying two pre-cast, spirally-reinforced, 8-ft-ID concrete pipes on rock mat foundations an average depth of 25 ft below the surface. Provisions have been made for shutting off either of the two tunnels for cleaning.

Circulating water is carried from the screen and pump chamber to the condensers and back to the discharge tunnels through 3-ft-ID, spirally-reinforced, spun-concrete pipe. Provisions were made in the screen and pump chamber for the future additions to the plant. The intake structure, at the request of the Harbor Department, was constructed to form a part of a future wharf. To obtain water at the lowest temperature, a baffle was installed to force the water supply to be drawn in at the lowest possible elevation.

Economic Studies

A series of comparable economic studies, based on ultimate plant

[2]Engineering features of the Boulder Dam, Los Angeles Lines, by E. F. Scattergood, A.I.E.E. proceedings, May, 1935.

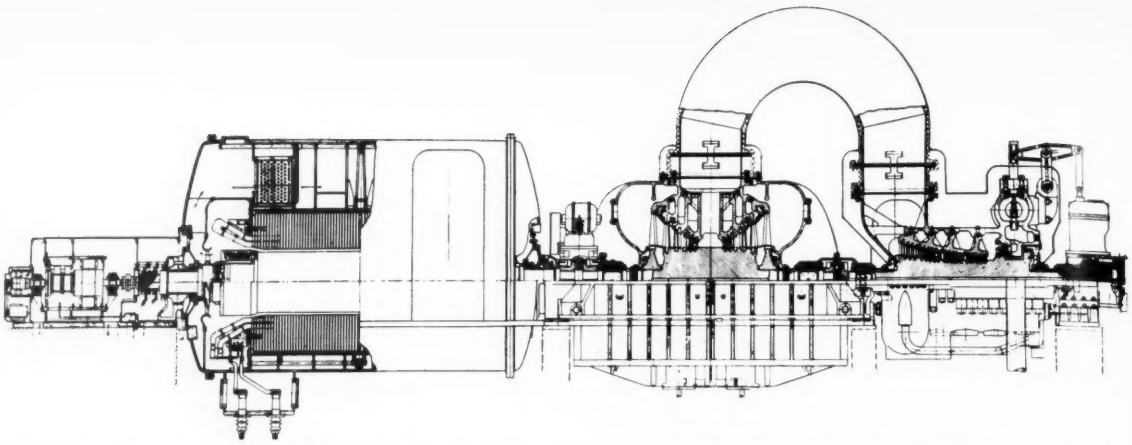


Fig. 3. Detailed cross-section of 65,000-kw, 3600-rpm tandem-compound turbine-generator unit, showing details of blading and generator hydrogen cooling

capacity of approximately 300,000 kw and on the net send-out from the plant, showed that, from the standpoint of economic cost, the nominal steam conditions at the turbine throttle should be 850 psi gage and 900 F and that a 65,000-kw, 3600-rpm, 0.8-power-factor, tandem-compound turbine-generator unit (the largest 3600-rpm unit manufacturers were prepared to build) was best suited to the required characteristics. An important factor in this selection was the small dimensions of the high-pressure cylinder because, upon instantaneous pick-up of load, rapid change of temperature from 700 F at light load to 900 F at full load in three to five minutes will affect only the relatively small high-pressure turbine.

It was also decided that steam should be supplied by a single steam-generating unit having a continuous capacity of 570,000 lb of steam per hour (corresponding to 65,000 kw) and a two-hour capacity of 675,000 lb of steam per hour (corresponding to overload at 75,000 kw), designed to burn fuel oil or natural gas.

Turbine-Generator Unit

A longitudinal section of the turbine-generator unit is shown in Fig. 3. While this is the largest 3600-rpm condensing unit in the United States, it is by no means experimental. All designs and parts have been tried out in actual service. Nominal steam conditions at the throttle are 850 psi gage and 900 F but the turbine is designed to operate with 1050 psi gage and 900 F steam at the throttle at low load and to carry 75,000 kw load with steam at 800 psi gage and 900 F steam at the throttle and a back pressure of 1.25 in. Hg absolute. Guaranteed governor regulation for 50 per cent change in load is 2 per cent and guaranteed maximum overspeed permissible is 12 per cent. The turbine is equipped with a load-limiting device and a low-pressure limiting device. Steam is extracted at the 8th, 15th, 21st, and 25th stages for heating the feedwater to 400 F at 65,000 kw load.

The electric generator is a two-pole, 60-cycle, 3-phase, 13,800-v unit with a nominal capacity rating of 82,000 kva at 0.5 psi gage hydrogen pressure. The generator is designed so that the hydrogen pressure may be increased to 15 psi gage, thereby increasing the rating to 93,750 kva, which at 0.8 power factor corresponds to 75,000 kw, the maximum output of the turbine. Exciter and pilot exciter are direct-connected 3600-rpm units.

One construction feature was the method employed to reduce vibration, always present in large two-pole generators of this type. The stator core and winding, source of the double-frequency vibration, was separated from the stator frame housing so that the only point of contact between them is where the generator rests upon its foundation. This is accomplished by supporting stator core and coils on a number of vertical steel columns, which effectively serve as vibration dampers.

Rotor dimensions are of interest because of the unusual length; diameter is 39 in. and total length 24 ft between bearing supports. The exciter is provided with duplicate brush holders to permit replacement of brushes while in operation.

Steam-Generating Unit

The steam-generating unit consists of boiler, water walls, superheater, submerged type desuperheater, economizer, regenerative-type air preheater, and combination oil and gas burners, all inclosed by a metal covered setting. As seen from Fig. 4, the boiler is of the three-drum, bent-tube type with a fourth or dry drum to prevent carry-over of solids. The superheater is of the pendant type with an intermediate header from which part of the steam is diverted by an automatic device through the desuperheater to maintain a constant steam temperature at the superheater outlet of 915 F plus or minus 10 F. There are ten combination oil and gas burners (to which pulverized coal burners may be added), each having a capacity of 6000 lb of oil per hour.

Cubical content of the boiler below the centerline of the main steam drum is 3500 cu ft. The pressure is maintained constant in the main steam drum at 1050 psi gage which, allowing for pressure drop through the superheater and main steam line, will provide 850 psi steam at the turbine throttle at full load. The steam-generating unit is supported by its own structural steel, entirely independent of the building.

Quick Pick-Up of Load

Requirement of quick pick-up of load especially affected the design of the boiler. When the turbine-generator unit is floating on the line carrying 5000 kw load, the turbine is operating on a "blocked governor" and consuming steam at the rate of 60,000 lb per hour; under these conditions the furnace is burning fuel oil at the rate of 4320 lb per hour. When the load on the turbine-generator unit is suddenly increased, the momentary slowing of the speed of

the unit trips the blocked governor, the turbine admission valves open to a point determined by a pre-set load-limiting device and the rate of steam flow increases almost instantly from 60,000 lb per hour to approximately 500,000 lb per hour. Under these conditions, it will take 20 to 25 sec to increase the firing rate of the fuel and, during this period, the additional steam required to carry the additional load will have to come from the accumulator effect of the heat stored in the hot water in the boiler.

Heat stored in the hot water is changed into steam by a drop in the boiler pressure. This drop is limited by the lowest steam pressure at the throttle at which the turbine can carry the load. For this maximum permissible drop in pressure, each pound of water in the boiler will release a given amount of heat in the form of steam. It follows, therefore, that the higher the initial pressure in the boiler when the turbine-generator is carrying 5000 kw, the greater the amount of stored energy available during the 20 to 25-sec period required to increase the rate of burning fuel to a rate greater than that required to produce 500,000 lb of steam per hour. This will not only stop the drop in boiler pressure but will put back the heat necessary to restore, in a few minutes, the normal boiler pressure and temperature of steam. Therefore, the boiler contains the largest practicable volume of water and the steam pressure is kept constant in the steam drum. The advantages of this are shown on Fig. 6.

Quick pick-up of load also requires forced and induced draft fans to have unusually wide range of output; namely, from 7 per cent to 150 per cent of the amount required at 65,000 kw load on the generator.

The extremely wide range through which the forced and induced draft fans operate for picking up load from 5000 to approximately 65,000 kw and the rapidity with which the change has to be accomplished presented an interesting problem in auxiliary drives. Various methods were examined from the standpoint of reliability and adaptability to these operating requirements. It was found that variable-voltage, direct-current control was the only method that would meet all of these requirements. This method was adopted and duplicate systems of fan drive and control were installed, comprising two motor-generator sets for driving the fans and two for controlling the speed.

Each motor-generator set for driving the fans consists of a 975-hp induction motor coupled to two direct-current generators, one generator furnishing power for the induced-draft-fan motor and the other for the related forced-draft-fan motor. Each motor-generator set for controlling the speed consists of a 20-hp induction motor coupled to a constant-voltage exciter, two variable-voltage Regulex exciters, and two variable-voltage speed exciters.

The method of operation is as follows: under normal conditions both motor-generator sets will be running and the speed of the fan motors will be controlled by the magnitude of the voltage of each generator. The magnitude of this voltage is controlled by a Regulex type of exciter. Each fan motor has a direct-coupled tachometer generator, the output of which is balanced against the output of its respective speed exciter. The differential output between these two units is used to control the output of the Regulex generator, which in turn directly controls the voltage of the main generator driving the fan motor. When the outputs of the two machines are balanced, the system is stabilized for that requirement of load, since the fan speed matches that called for by the automatic combustion con-

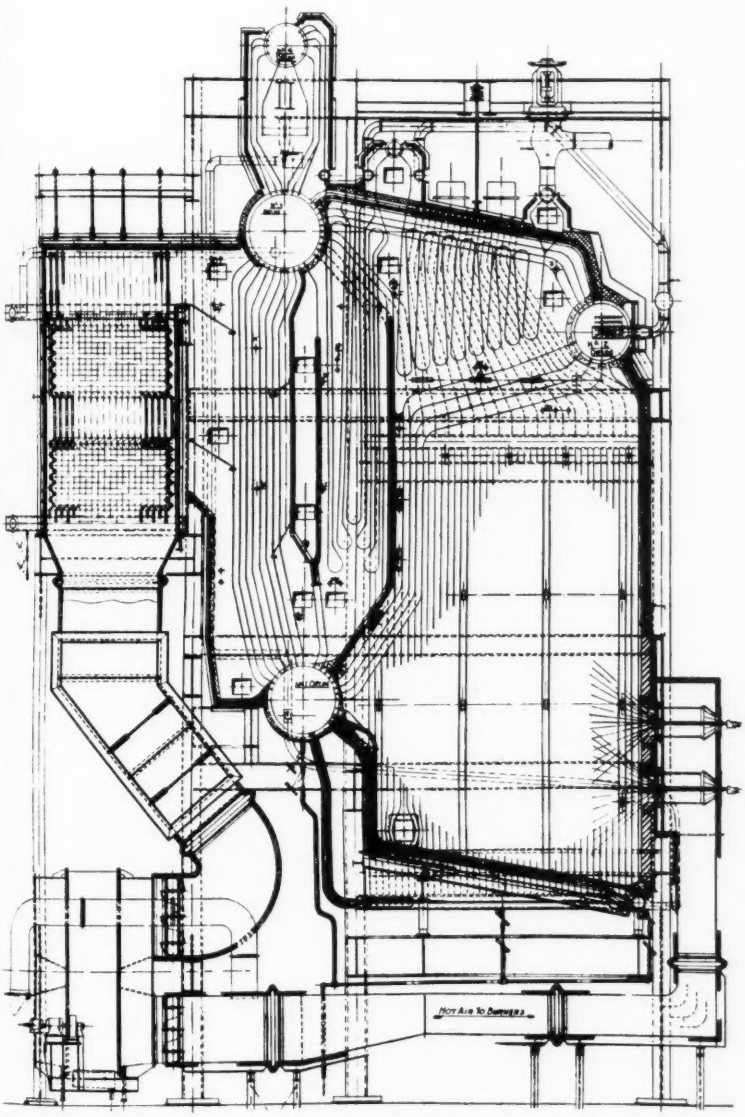


Fig. 4. Details of the single 3-drum bent-tube steam-generating unit, showing dry drum, tube and furnace details, superheater and submerged type desuperheater, combination oil and gas burners

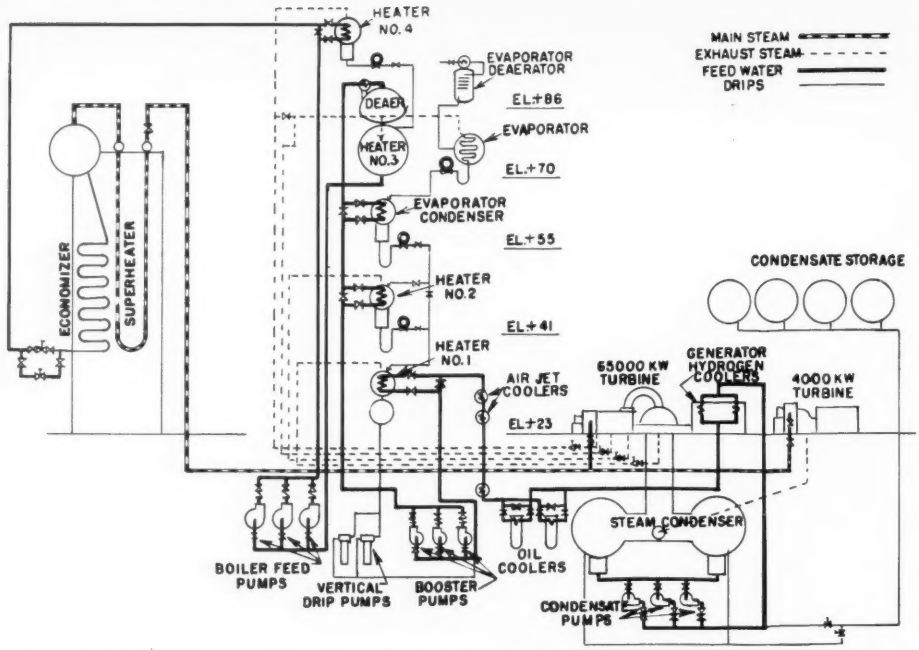


Fig. 5. Diagram of heat flow of Harbor Steam Plant. Heaters in vertical line provide gravity flow for cascading drips. Note deaerating heater in No. 3 position. Steam extracted from 8th, 15th, 21st and 25th turbine stages heats feedwater to 400 F at 65,000 kw load. House turbine exhausts to main twin condensers

trol equipment of the steam-generating unit.

Maximum performance required of this control system is that the induced draft fans be varied in speed from standstill to 1025 rpm in 14 sec and the forced draft fans from standstill to 1370 rpm in the same time interval, with speed control throughout the entire range in steps not greater than 5 rpm.

Heat Balance

Heat flow of the station is shown diagrammatically in Fig. 5. The heaters are arranged one above the other, thus obtaining gravity flow for cascading drips.

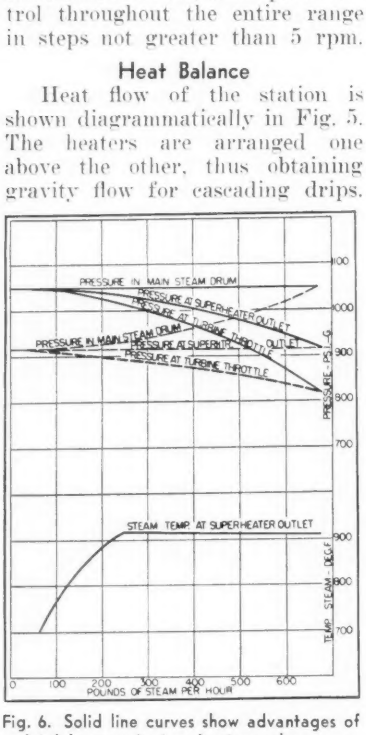


Fig. 6. Solid line curves show advantages of maintaining constant main steam drum pressure, for quick pick-up of load on spinning turbine generator, as compared with constant superheater outlet pressure conditions, as shown by broken line curves

The deaerating heater is in the No. 3 position instead of the No. 2 position. Condensate is used in the generator hydrogen coolers, the oil coolers and the steam jet condensers and provision is made for maintaining the condensate at a sufficiently cool temperature by recirculation to the condenser hotwell. A three-way valve is provided to divert the recirculating condensate over the condenser tubes when necessary.

The calculated overall heat consumption of the entire plant is about 11,400 Btu per kilowatt hour net station send out at 75 per cent load, when burning fuel oil.

Twin Main Steam Condenser

From economic studies it was decided that the main steam condenser should have 60,000 sq ft of condensing surface with provision for 48,000 gpm of cooling water, which would also make it possible to obtain the maximum load of 75,000 kw during the six winter months when the temperature of the cooling water would be 60 F or cooler and when such maximum capacity would be most likely to be needed.

Difficulties arose in trying to place such a large condenser in the conventional crosswise position directly under the turbine exhaust, because of the comparatively small dimensions of the 3600-rpm low-pressure turbine. The only way it could have been done would have been by installing a tall, narrow condenser under the turbine. This would have placed the 932,000-lb turbine-generator unit at an unusually high elevation. This was undesirable for many reasons, including the difficulty and added expense of designing the foundations to withstand earthquake shocks.

After thorough consideration, it was decided to install two half-size condensers longitudinally on each side of the low-pressure turbine foundation, with a connecting piece between the turbine exhaust and the two condensers.

Advantages of this arrangement include: (1) Low center of gravity of the turbine-generator unit and consequent favorable conditions for foundation design, particularly against earthquake; (2) a low, broad foundation to carry both the turbine-generator unit and the condenser, which, through wide load distribution, greatly simplified foundation design; (3) solid bolting of the condenser on its foundations instead of troublesome spring supports, differential expansion being taken care of by rubber-fabric expansion joints between each condenser and the connecting piece; and (4) locating the turbine-room operating floor on the same level with the boiler-room operating floor and only 5 ft above ground level.

Plant Layout

The geographical conditions greatly affected the arrangement. As shown in Fig. 1, fuel and circulating water enter the plant from

(*Continued on Page* 114)

Principal Equipment in Harbor Steam Plant, Bureau of Power & Light, Los Angeles, Calif.

Steam Generating Unit and Auxiliaries

Steam Generating Unit—1 Riley Stoker Corp. semi-tube boiler; bare-tube water walls, pendant-type superheater; capacity 570,000 lb steam per hr continuously, 675,000 lb steam per hr for two hrs; steam working pressure 1050 psi constant in drum; steam temperature at superheater outlet 915 F at 250,000 lb steam per hour or more; sq ft heating surfaces, boiler 24,100, water walls and floors 6800, superheater 23,300, economizer 12,000, two Ljungstrom air preheaters 46,400 total, other parts 770; furnace volume 22,500 cu ft; ten Peabody Type H-26 combination oil and gas burners.

Automatic Controls—Bailey Meter Co. air-operated; combustion control, boiler feedwater control, control of condensate pumped by booster pumps, by-pass recirculation of condensate, by-pass recirculation of boiler feedwater, and condensate system control (make-up and draw-off).

Fuel Oil Transfer Pumps—3 Quimby Pump Co. constant displacement 2-speed pumps, each driven by General Electric 100-hp 900/450-rpm, two-speed, 2300-v motor; each pump 300 gpm, 900 rpm, 250 psi discharge press. and 150 gpm at 450 rpm, 500 psi discharge press.

Fuel Oil Service Pumps—2 Quimby Pump Co. constant displacement pumps, 150 gpm; one driven by 880-rpm 75-hp motor, the other by a two-speed 880/440-rpm 75/37.5-hp motor. Motors 440 v, Ideal Electric & Mfg. Co.

Fuel Oil Differential Pumps—2 United Iron Works centrifugal pumps; each 125 gpm against 175 lbd 150 psi; each driven by 25-hp, 3450-rpm United States splash-proof 440-v motor.

Fuel Oil Heaters—C. F. Braun & Co.; 3 high-pressure, horizontal, 405 sq ft each; 3 low-pressure, horizontal, 315 sq ft each, 3 horizontal, 100-sq ft each drain coolers; 3 horizontal flash tanks; all straight tubes and floating heads.

Induced Draft Fans—2 American Blower Corp. radial tip; guaranteed capacity each 205,000 cfm at 15 in. water, 420 F, 1390 rpm. Each driven by variable-speed d-c motor (see **Fan Drives**), speed range 45 to 1080 rpm.

Forced Draft Fans—2 American Blower Corp. backward curved; guaranteed capacity each 125,000 cfm at 18 in. water, 100 F, 1390 rpm. Each driven by a variable-speed d-c motor (see **Fan Drives**), speed range 60 to 1440 rpm.

Heaters and Pumps

Closed Feedwater Heaters—4 Westinghouse horizontal, straight tube, floating head; No. 1 heater 2230 sq ft, ¾ in., 18 BWG admiralty tubes; No. 2 heater 1555 sq ft; ¾ in., BWG admiralty tubes; evaporator condenser 820 sq ft, No. 4 heater 2155 sq ft, ¾ in., 12 BWG steel tubes.

Deaerating Heater—1 Permutit Co. spray type, 750,000 lb per hr, 150 psi, with 250,000 lb water storage; dissolved oxygen content guaranteed 0.005 cc per liter or less under all conditions.

Evaporator—1 Foster Wheeler Corp. Type H submerged coil, 15,000 lb per hr, 1 in.—16 BWG admiralty tubes; includes evaporator blow down heat exchanger.

Water Treatment Plant—Permutit Co., 2 pressure-type carbonaceous Zeolite softeners, 1 de-aerating unit, 1 phosphate feeder, 1 salt storage tank, 1 brine measuring tank and appurtenances; capacity 72,000 gal between regenerations, regeneration period 60 min.

Boiler Feed Pumps—3 Byron Jackson Co. horizontal, centrifugal, 3550-rpm 6-in. 9-stage barrel type, horizontally split inner casings; each 850 gpm deaerated condensate 360 F, 3410 ft dynamic head; each driven by General Electric 3600-rpm, 2300-v motor; one pump dual driven with additional General Electric 1000-hp, single-stage impulse turbine, steam 1050 psi, 900 F.

Booster Pumps—3 Ingersoll-Rand Co. horizontal, centrifugal, 3550 rpm, split casing; each 725 gpm, 88 F and 510 ft dynamic head; each driven by Westinghouse 125-hp, 2300-v motor.

Horizontal Condensate Pumps—3 Elliott Co.—Pennsylvania Pump & Compressor Co., centrifugal, two stage, split casing, 1160 rpm; each 1000 gpm, 79 F and 150 ft dynamic head; each driven by Westinghouse 50-hp, 440-v motor.

Vertical Condensate Pump—1 Byron Jackson Co. 4-stage, double-case, 1200 gpm, 79 F, 150 ft total head; driven by vertical Westinghouse 75-hp, 870-rpm, 440-v motor.

Drip Pumps—2 Byron Jackson Co. vertical 3 stage, double case, 335 gpm at 55 ft total head; driven by vertical Westinghouse, 7.5-hp, 1160-rpm, 440-v motor.

Miscellaneous Pumps—11 Pomona Pump Co. vertical deep well type for valve head tank, bearing cooling water, treated water, chlorinating water, condenser pit sump, steam generator sump, fuel oil service house sump, distilled water sump; 6 Buffalo Forge Co. horizontal centrifugal type soft water, raw water emergency, gland seal water, distilled water transfer, heat exchanger circulating water; 4 Peerless vertical deep well type for screen wash water, tunnel wash water, tunnel unwatering; 2 Byron Jackson horizontal centrifugal for evaporator feedwater; one Byron Jackson vertical sludge pump for tunnel cleaning.

Pump Driving Motors—All 3-phase, 60-cycle constant speed squirrel-cage motors unless otherwise listed.

Main Turbine Generator and Auxiliaries

Main Turbine Generator—1 Westinghouse Elec. & Mfg. Co. 3600 rpm, 65,000 kw at 0.8 pf; tandem-compound turbine, 21 stages high pressure cylinder (1 impulse and 20 reaction), 14 reaction stages in low pressure cylinder; nominal steam at throttle 850 psi gage, 900 F; back pressure 1 in. Hg abs; two-pole hydrogen-cooled generator, 81,250 kva 0.8 pf, 13,800 v, 3 phase, 60 cycle, 0.9 short circuit ratio, 0.5 psi hydrogen gas pressure; 93,500 kva at 15 psi hydrogen gas pressure; direct-connected main exciter 260 kw, 250 v; direct-connected pilot exciter 3 kw, 250 v.

Auxiliary Turbine Generator—1 Westinghouse Elec. & Mfg. Co., 3600 rpm, 4000 kw at 0.8 pf; single cylinder, 1 impulse stage and 36 reaction stages; throttle steam variable, 800—1050 psi gage, 900 F; back pressure 1 in. Hg abs; 5000-kva two-pole, air-cooled generator, 5000 kva, 0.8 pf, 2400 v, 3 phase, 60 cycle, 0.85 short circuit ratio; shaft-driven exciter, 35 kw, 3600 rpm, 250 v.

Lubricating Oil Purification System—S. F. Bowser & Co. continuous by-pass system; one 7000-gal new oil tank and two 3000-gal rest tanks; Bowser oil conditioner with 8 pumps; 1 De Laval oil purifier.

Main Steam Condenser—Elliott Co. twin, horizontal, two-pass, surface condenser with connecting piece; each condenser 30,000 sq ft containing 5040, ⅞ in., 18 BWG aluminum brass tubes 26 ft effective length; 24,000 gpm cooling water to each condenser; rated performance 1 in. Hg abs at 403,900 lb steam per hr total (65,000 kw) with 100 per cent commercially clean tubes; muntz-metal tube sheets, cast-iron water boxes; deaerating hotwell; steam jet air ejectors for 800-psi gage, 900-F steam.

Circulating Water Pumps—2 Pomona Pump Co. 709 rpm, vertical, single stage, mixed flow, each 24,000 gpm salt water against total head 28 ft; each driven by Westinghouse, 250-hp, 709-rpm, 2300-v, outdoor-type motor.

Traveling Refuse Screens—3 Chain Belt Co. screens; each 6 ft wide and 30 ft c to c of sprockets; each screen driven by General Electric 5-hp, 1725-rpm, 440-v, motor through 331.8-to-1 gear reduction.

Chlorinating Equipment—Wallace & Tiernan Corp.; semi-automatic controlled type ASHV, capacity 4000 lb chlorine gas per 24 hr; 4-point rate controller; automatic electric program controller; Pomona deep-well type chlorine injector supply pump.

Air Compressors—Sullivan Machinery Co.; One 350 cfm, driven by General Electric 75-hp 580-rpm, 440-v, 3-phase, 60-cycle squirrel-cage motor; one 100 cfm driven by General Electric 25-hp, 1760-rpm, 440-v motor.

Power Piping—Designed by Power Bureau engineers; valves furnished by Reading, Pratt & Cady, Chapman Valve Mfg. Co., Manning, Maxwell & Moore, Atwood & Morrill and others; piping furnished, shop fabricated and erected by Blaw-Knox Co.

Transformers and Switchgear

Main Power Transformers—4 General Electric Co. single-phase, outdoor-type, oil-immersed, power transformers 76,200-132,000 Y/13,200 Delta, capacity 22,500 kva self-cooled, 30,000 kva forced-air-cooled.

Generator Switchgear—Westinghouse Elec. & Mfg. Co. metal-enclosed switchgear equipped with Type 150 CA-1500 Air Circuit Breaker, disconnect switches and potential transformers. Air circuit breaker rating 4000 amp, 15 kv, 3-pole, single throw, 1,500,000 kva interrupting capacity; auxiliary air supplied by 2-stage motor-driven compressor delivering 6.5 cfm, with approximate storage capacity of 540 cu ft free air at 250 psi.

Neutral Switchgear and Reactor Cubicle—Kelman Elec. & Mfg. Co. metal-enclosed switchgear with Type 15 LA2-H-ID oil circuit breaker, 3000 amp, 15 kv single pole, single throw equipped with General Electric Type CLS-60 reactor, 48,000 amp, single phase, dry type, indoor.

Auxiliary Power Transformers—Pennsylvania Transformer Co. 3-phase, 60-cycle, outdoor-type, oil-immersed, self-cooled, power transformer, 13,200-2400 v, capacity 5000 kva; Moloney Electric Co. 3-phase, 60-cycle, outdoor-type, oil-immersed, self-cooled transformer, 4800-2400 v, capacity 2000 kva.

Auxiliary Power 2300-v Switchgear—Kelman Elec. & Mfg. Co. metal-enclosed drawout-type switchgear, consisting of 20 cubicles and containing two 7.5 RA2-A-ID, 2000-amp, 7500-v, 3-pole, single-throw, oil circuit breakers and 18 type 7.5 LA2-A-ID, 600-amp, 7500-v, 3-pole, single-throw, oil circuit breakers.

Miscellaneous Auxiliary Power 2300-v Switchgear—Kelman Elec. & Mfg. Co. metal-enclosed drawout-type switchgear consisting of 14 cubicles in four separate units, each employing type 7.5 L2-A/3, 400-amp, 7500-v, 3-pole, single-throw, oil circuit breakers.

Auxiliary Power 400-v Switchgear—Westinghouse Elec. & Mfg. Co. metal-enclosed switchgear employing 64 Type DK-25 drawout De-ion 600-v, a-c, 3-pole, single-throw, air circuit breakers.

Miscellaneous Auxiliary Power 440-v Switchboards—Square D Co. dead-front and dead-rear switchboards equipped with fifty-two 3-pole, 500-v, dead-front-operated knife switches, 3-pole, 600-v air circuit breakers, motor starters and miscellaneous equipment.

Draft Fan Drives and Control—Allis-Chalmers Mfg. Co. Regulex control, consisting of two motor-generator sets, each with 975-hp 2300-v, 3-phase, 60-cycle, 1183-rpm motor, 400-kw, 550-v, d-c generator for driving induced-draft fan motor and a 250-kw, 600-v, d-c generator for driving forced-draft fan motor; two Regulex control sets, each consisting of an induction motor, a main exciter, two Regulex exciters and two speed exciters; two 500-hp, 550-v, 1080-rpm, d-c, induced-draft fan motors; two 300-hp, 600-v, 1440-rpm, d-c, forced-draft fan motors; 1 metal-enclosed cubicle containing all control devices.

Switchboards, Control House—Three vertical panels and one bench board type, designed and built by Bureau of Power and Light. Switchboards steel frame, steel panel. Bench and meter board circular.

Station Storage Batteries—2 Electric Storage Battery Co. Exide Type FM-17 storage batteries, 120 cell, 640 amp-hr, 250 v. One Exide Type DMGO-17, 34 cell, 60 amp-hr, 68 v.

Motor Generator Charging Sets—2 Westinghouse Elec. & Mfg. Co., Type CS-SK, 10 kw.

Communication and Alarm Systems—Automatic Electric Co. 100 line PAX telephone system with code call equipment; manual telephone system designed and built by the Bureau of P. & L. for direct communication control house to turbine and boiler control boards; alarm system designed and built by Bureau of P. & L. consisting of illuminated-front panel annunciators.

Traveling Crane, Power House—Cyclops Iron Works 125-ton, 94 ft span; main and auxiliary hooks. Main hook capacity 125 ton, travel 5 fpm; auxiliary hook capacity 25 ton, travel 20 fpm. Bridge travel 150 fpm, trolley travel 75 fpm; each hook and hoist designed for 25 per cent overload.

Traveling Crane, Screen and Pump Chamber—Cyclops Iron Works 25-ton traveling crane, 57 ft span. Main hook capacity 25 ton; auxiliary hook capacity 5 ton.

Fire Protection—Cardox Corp. low-pressure CO_2 system containing 4 tons of refrigerated CO_2; Oil Field Construction Co. foam system which includes two bins and hoppers, three generators with 20,000 lb powder storage in hoppers and 20,000 lb can storage, six hose stations, three hose carts, three foam applicators on each fuel oil storage tank; high-pressure water booster pump for foam system.

Auxiliary Driving Motors—All 3-phase, 60 cycle constant speed, squirrel-cage induction motors unless otherwise listed.

Keep Them Pumping

Part I. This two-part serial article on the care of pumps is a plea to the operator for more careful attention to details of pump operation, particularly those pumps in out-of-the-way places. Inspection alinement, lubrication, and suction conditions which are essential to good operation are outlined here. Other details will be treated in Part II

By J. O. Glenn, ***Standard Products Division, Worthington Pump and Machinery Corp.***

IN THE AVERAGE industrial plant we see many machines, neatly painted, scrupulously cleaned and obviously well oiled. These are generally large compressors, engines, large pumps or turbines, equipment involving a relatively large investment and the pets of the maintenance crew. On the other hand a highly polished small pump is a rarity. Frequently located off in a dark corner, the lowly small pump simply does its job, patiently and without glamour, until from starvation or neglect it is forced to give up.

Such pump shutdowns seem to happen at the worst possible time; and the result is invariably costly both from the standpoint of repair parts and interrupted plant production. Many of these pump failures can be avoided by a better understanding of the causes with steps to prevent their recurrence.

The following discussion applies in the most part to pumps in service. New installations, foundations or new piping have no part in the subject which is aimed purely at the conservation of equipment in operation or on hand.

Is Maintenance Controlled?

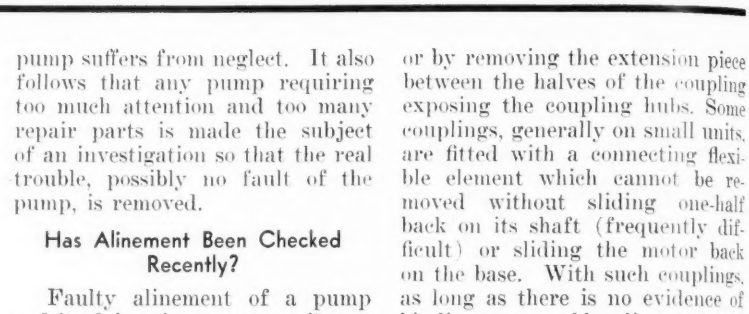
Many general overhauls can be avoided by scheduled inspections that will disclose trouble in the making. A nut tightened here and a minor adjustment there can be considered a small insurance premium against major replacements. A permanent record system with a page or card for each pump is almost a necessity for controlled maintenance. Such records should include pump size, serial number, name and address of manufacturer, conditions of service, date installed, trade names or grades of lubricants recommended, dates of complete inspections and dates and nature of repairs. In such a manner no pump suffers from neglect. It also follows that any pump requiring too much attention and too many repair parts is made the subject of an investigation so that the real trouble, possibly no fault of the pump, is removed.

Has Alinement Been Checked Recently?

Faulty alinement of a pump and its driver is a common ailment that has contributed more than its share to unnecessary service and replacement of damaged parts. The fact that alinement was carefully checked at the time of installation is no assurance that, a year later, piping strains, shocks, settling of foundations or other causes have not made a change in the relationship of the two rotating shafts. A flexible coupling will compensate for slight variations in alinement which may occur during normal operation. It will not however, take care of any appreciable misalinement which through distortion can ruin shafts, bearings, stuffing box parts and the coupling itself.

On a coupled pump unit it is generally difficult to check alinement accurately unless each shaft is free to rotate independently of the other. With some couplings this is accomplished merely by removing the coupling bolts or pins or by removing the extension piece between the halves of the coupling exposing the coupling hubs. Some couplings, generally on small units, are fitted with a connecting flexible element which cannot be removed without sliding one-half back on its shaft (frequently difficult) or sliding the motor back on the base. With such couplings, as long as there is no evidence of binding, reasonable alinement can be secured with the coupling intact.

The following method, with possibly a few variations, may be followed in checking alinement with virtually all types of couplings.



Method of checking coupling alinement

Place a straight-edge across the top and side of the coupling and with a feeler gage check the faces of the coupling halves as illustrated in the accompanying sketch. When the peripheries of the coupling halves are true circles of the same diameter and the faces flat, exact alinement exists when the straight-edge lies squarely across the rims at all points and the distance between the faces is the same at all points.

With a steam turbine driven unit, final alinement should be made with the turbine heated to its operating temperature. Similarly, if the pump handles a hot

liquid, allowance must be made for elevation of the shaft when the pump expands.

It is a good idea to check the distance between the faces of the two coupling halves to make sure they cannot rub or exert pull on either the pump or the driver. The amount of this clearance will vary with the size and type of coupling used. A good rule is to allow enough space for unhampered endwise movement of the shafts. On motor driven units the magnetic center of the motor will determine the running position of the motor half coupling.

If a pump is directly connected by gears to a motor or engine the pinion should not be meshed into the gear too closely. A slight amount of clearance or back-lash is desirable. For small and medium size gears a clearance of 0.005 to 0.008 in. is about right. For large gears the clearance should approximate 0.010 in. per inch of circular pitch. If considerable moisture is present, allowance must be made for expansion of a fiber pinion.

There must be a perfect bearing across the entire width of the pinion and gear faces. A good method to check this is to coat the gear teeth lightly with red lead, turn the gear by hand and observe the contact marks on the gear teeth. These should be equal for the entire length of the tooth.

An occasional check of alinement and the use of a few shims will avert many a shutdown with its accompanying headaches.

Are Any Pumps Suffering for Want of Proper Lubrication?

While lack of lubrication through sheer neglect takes its toll, faulty lubrication administered by a conscientious operator is frequently the root of trouble and the cause of replacements.

Normally, grease lubricated ball bearings, when suitably filled with a high grade of ball bearing grease, require little attention. Lubrication every 1000 hr. (usually about six months) is adequate. The old grease should be removed entirely and new grease applied until the bearing housing is about ⅓ or ½ full. A ball bearing in a conventional housing pressed full of grease will usually overheat.

Pumps having oil lubricated ball bearings are generally provided with a device for controlling the prescribed oil level. A grade of oil, only as recommended by the pump manufacturer or by a competent lubrication specialist, should be used. The seals on the bearing housings require periodic inspection to guard against excessive oil leakage.

Ring oiled sleeve bearings call for regular inspection to determine whether the oil rings are turning freely and supplying enough oil to the shaft and bearings. It is recommended that at least once every six months the reservoirs of such bearings be drained, washed out and refilled with a good grade of medium machine oil.

Open frame power pumps require occasional lubrication of the bearings and the crossheads, the method depending upon the manufacturer's recommendations for each particular style of pump. The teeth of the pinion and gear must be kept thoroughly coated with a good adhesive heavy bodied lubricant which will not only resist squeezing out but will furnish a sufficient cushion to prevent metal to metal contact. Gears operating in oil-tight guards or cases should not be flooded since too much oil causes heating. The oil level should be such that the edge of the gear dips in the oil.

Enclosed frame power pumps are generally lubricated entirely from the reservoir in the crankcase. This calls for little attention other than keeping the oil level at the prescribed point and an occasional change of oil, say about every 1000 hr. of operation. For a room temperature of about 70 deg. F. a good grade of SAE No. 40 oil, when there are no gears operating in the crankcase, will usually be found satisfactory. When there are gears, SAE No. 60 oil is preferable.

A steam pump should receive constant attention. It is recommended that all bearings, joints, valve rods and piston rods be lubricated before starting and at reasonably frequent intervals during operation. Lubrication should be frequent, but not so abundant as to gum or clog joints. A good grade of mineral oil is satisfactory for the steam cylinder and a lighter grade of good mineral or animal oil will take care of rods and valve gear. It should be remembered that the slow speed steam pump, if neglected, will rarely sound a warning protest. It will just wear out and quit.

Since internal bearing rotary pumps require no lubrication, it is sometimes overlooked that some rotary pumps are equipped with external bearings requiring the usual attention.

A good pointer on lubrication is to list all pumps according to style and type of bearings and secure the recommendations on grades of lubricant, according to type or trade name, from a competent representative of your supplier.

What About Suction Conditions?

A poor suction condition prevents a pump from being fed its full capacity. So throttled, the average pump will develop sufficient vacuum on the suction side to create vapor in space normally filled with liquid. These "slugs of air" cause uneven or shock loads on any pump. This condition may not be so severe as to cause vibration. With a centrifugal or rotary pump, however, it may be detected by a crackling

(*Continued on page* 138)

Table giving positive and attainable suction heads at various altitudes and water temperatures to be used only as a guide

	WATER TEMPERATURE															
Altitude	212°F.	200°F.	190°F.	180°F.	170°F.	160°F.	150°F.	140°F.	130°F.	120°F.	110°F	100°F.	90°F.	80°F.	70°F.	60°F.
Sea level	12	10	7	5	3	0	2	4	6	8	11	13	15			
2,000 feet	14	12	10	7	5	3	1	1	4	6	8	10	12	15		
4,000 feet		14	12	10	7	5	3	1	1	4	6	8	10	13	15	
6,000 feet		16	14	12	10	7	5	3	1	1	4	6	8	10	12	15
8,000 feet			16	14	12	10	7	5	3	1	2	4	6	8	10	12
10,000 feet			18	16	14	11	9	7	5	2	0	2	4	6	8	11
	POSITIVE SUCTION HEAD REQUIRED - FEET										ATTAINABLE SUCTION LIFT - FEET					

A New Armature Winding Diagram

Part II

In this second part of his description of a new armature winding diagram, Mr. Taylor takes up in greater detail the application of his method to the layout of actual windings. Among others, he describes the layout of basket, mesh and lap windings, and shows how to extract the winding tables from the diagrams. As with Part I, published in the April issue, a series of questions and answers are given at the end of the article to clear up doubtful points

By WILLIAM T. TAYLOR

WHILE GENERATOR and motor windings form the prime and major sources of electric power for industries, relatively little is known of their layout and connections by those operating them. Can the chief cause be traced to lack of a satisfactory graphic method?

Lack of knowledge gives thought to the unknown happening any time, day or night, and this brings fear to power house and industrial engineers. Certainly all operators without the necessary knowledge are at a disadvantage and the service expected of them is likely to be at its worst just at the time it should be at its best, i.e. the time of a burn-out or when the operating staff is new or when some emergency change in a winding is most urgently needed.

Due almost entirely to the fact that conventional winding diagrams are of mechanical construction and ignore such fundamentals as slot-pole-phase relationship, equi-potential, electrically-identical, phase lead and electrical angular degree positions, no attempt can be made herein to coordinate them nor compare their relative advantages as to simplicity, adaptability and general usefulness. In practice it is the simplicity and utility of a diagram or method that matters the most and there appears to be no better way of proving these than by displaying actual working examples of the different classes and types of windings. Diagrams for different winding layouts such as given herein tell their own story.

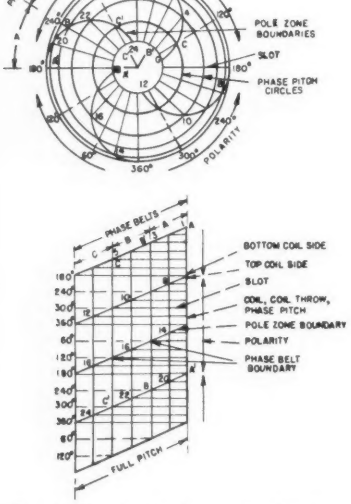


Fig. 1. Showing basic construction for 3 phase 4 poles

Fig. 1 illustrates the basic construction of these methods — a compass and straight-edge only need be used for the purpose. In the *straight-line* diagram of Fig. 1 for two-layer windings, the upper ends of vertical lines coming between pole zone boundaries indicate top (T) coil sides and the lower ends indicate bottom (B) coil sides for full- or fractional-pitch, hence there is no need to mark them (T) or (B). The positions of vertical lines also indicate phase and phase pitch; coil throw and pitch of the winding are indicated by the respective lengths of these lines. Full pole-pitch (180 deg.) intersects two adjacent pole zone boundaries and alternate (2p) pole zone boundaries intersect electrically identical coil sides positions. Auxiliary pole zone boundary lines (curves or semi-circles for the polar diagram) are commonly included in diagrams for chorded lap and wave windings, the winding table of coil-side connections can then be read between a full-pitch pole zone boundary and the next adjacent fractional-pitch pole zone boundary line which latter are all bottom (B) coil sides positions. The electrical degree angles and resulting phase-current overlap of coil-sides in the different phase belts are also shown. All diagrams show that full-pitch equi-potential electrical-

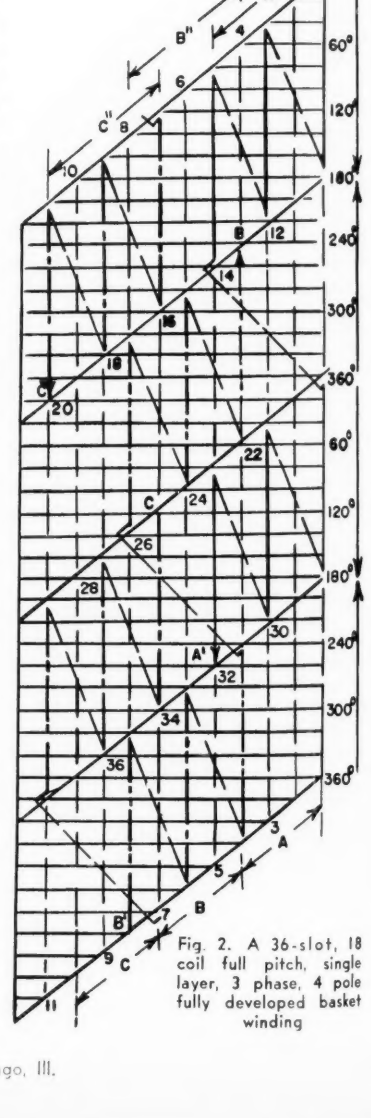


Fig. 2. A 36-slot, 18 coil full pitch, single layer, 3 phase, 4 pole fully developed basket winding

ly identical and phase-to-neutral lead (2 layer) winding positions lie on the same vertical line;—hence they virtually constitute what may aptly be called a connection checker.

In the polar diagram each circle identifies the equi-potential electrically-identical and phase pitch positions through all the poles. In the straight line diagram, which is recommended for general use, each vertical line passing between all the poles identifies the same positions referred to here.

The layout of a winding on the core of a rotating electrical machine adheres to slot-pole-phase relationship and the layout of these diagrams follow the same relationship. Moreover, the diagrams are adaptable to windings displaying change in the number of phases for a change in the number of poles or displaying change in the number of poles (speed change) for a change in the number of phases.

In actual practice the 2-layer-lap winding permits of exceptionally wide use when, due to coil failure, it is desired to get the best operating results and winding symmetry with an odd or mixed number of coils per pole per phase. For such conditions the proposed diagram can be regarded more than equally as flexible and therefore well suited to illustrate every possible adaptation of this type of winding.

The single-layer or one-coil-side-per-slot winding, such as the concentric, basket, mush and certain other types, are less common than the 2-layer lap and wave types shown in Part I,[1] but they are given here to show the adaptability and simplicity of this diagrammatic method. This is so whether the phases or/and the magnetic pole areas overlap or not due to unequally grouped coils on the one hand and to fractional-pitch coils on the other hand.

Fig. 2 shows a 36-slot, 18-coil (1½ coils per pole per phase), full-pitch, single-layer, 3-phase, 4-pole fully developed Basket winding. It is seen that this winding is distinguishable by its interleaved phase zones, indicating how this

[1]Page 78 April issue.

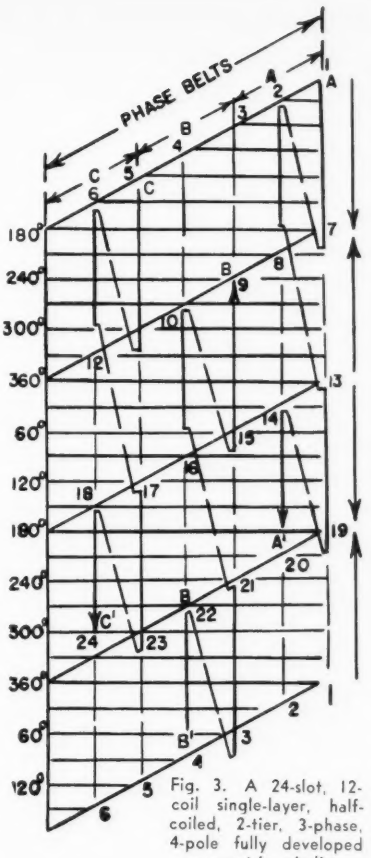


Fig. 3. A 24-slot, 12-coil single-layer, half-coiled, 2-tier, 3-phase, 4-pole fully developed concentric winding

type derived its name. A fully developed winding table extracted from Fig. 2 is given below

Phase leads A-B-C and neutral leads A′-B′-C′ are seen to have 240 electrical degree displacement between phases. Disposition of coil grouping within the pole areas resemble that shown in Fig. 3 but each phase of the basket winding is seen to invade adjacent phase zones whereas the type in Fig. 3 invades magnetic pole areas in another way. The three solid vertical lines of Fig. 2 at the top right represent coils and full-pitch coil throw of phase A; the three dash-dot vertical lines to the top left represent coils and full-pitch coil throw of phase C; and the three dash-two dot lines in the center represent coils and full-pitch coil throw in phase B.

Fig. 3 displays a 24-slot, 12-coil, single-layer, half-coiled, 2-tier, 3-phase, 4-pole, fully developed concentric winding. We see that the pole-phase group series-connections are uni-directional and that two of the 120 deg phase-lead positions occur under one polarity and one under a different polarity. Extracted from Fig. 3 the winding table reads

A	1	8	-	2	7	-	13	20	-	14	19	A′
	0°				180°		360°				180°	
B	9	16	-	10	15	-	21	4	-	22	3	B′
	240°				60°		240°				60°	
C	5	12	-	6	11	-	17	24	-	18	23	C′
	120°				300°		120°				300°	

Solid thick vertical lines such as those between slots 1 and 8, 2 and 7 represent the coils and coil throw; broken oblique lines between adjacent coils represent coil-to-coil connections; solid lines slanting downwards from right to left represent full-pitch pole zone boundaries.

Another class of winding on the same base diagram is Fig. 4, which displays a 4-pole, 3-phase, 24-slot, 12-coil, coil-throw 1 and 6, single-layer, whole coiled *mesh* winding. Compared with the similarly connected concentric winding this class can be distinguished by its coils which are all of the same

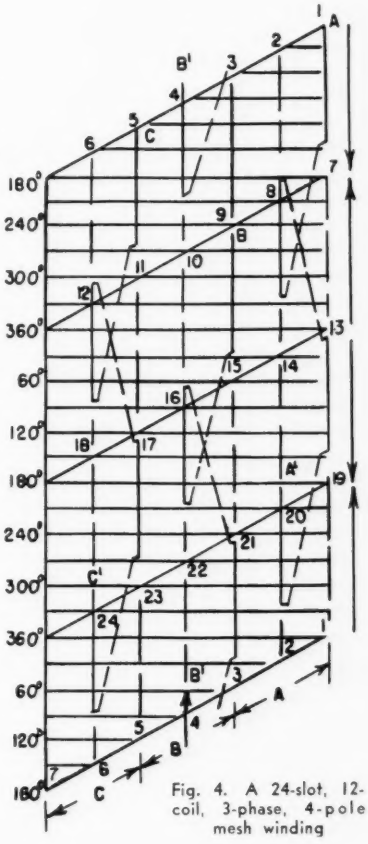


Fig. 4. A 24-slot, 12-coil, 3-phase, 4-pole mesh winding

A	1	10	-	3	12	-	5	14	-	19	28	-	21	30	-	23	32	A′
	0°	180°		40°	220°		80°	260°		360°	180°		40°	220°		80°	260°	
B	13	22	-	15	24	-	17	26	-	31	4	-	33	6	-	35	8	B′
	240°	60°		280°	100°		320°	140°		240°	60°		280°	100°		320°	140°	
C	25	34	-	27	36	-	29	2	-	7	16	-	9	18	-	11	20	C′
	120°	300°		260°	340°		200°	40°		120°	300°		260°	340°		200°	40°	

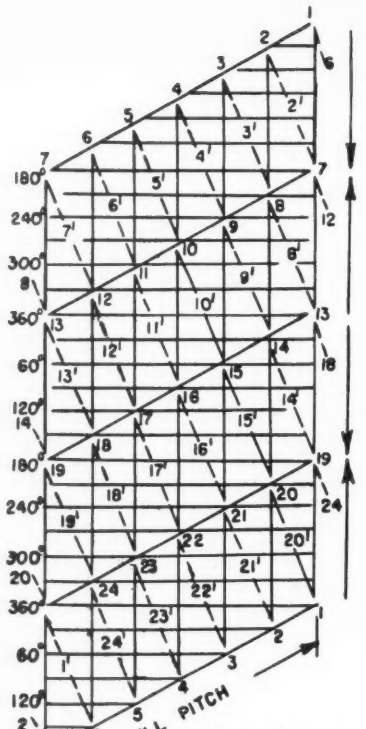


Fig. 5. A 24-slot and coil D-C lap winding with 24 commutator segments

shape and have no coil-end tiers or ranges. The extracted winding table taken from Fig. 4 reads:

							Phase
A	1	6-12	7-13	18-24	19	A′	Overlap
	A	C	C	A	A	C	C	A	A - C
B	9	14-20	15-21	2-8	3	B′	
	B	A	A	B	B	A	A	B	B - A
C	5	10-16	11-17	22-4	23	C′	
	C	B	B	C	C	B	B	C	C - B

A still more distinctive example on the same base diagram is Fig. 5, which displays a d-c, 4-pole, 24-slot and coil, 2-layer, full-pitch, 1 and 7 coil-throw, *lap* winding with connections to 24 commutator segments. These latter may be regarded as being external to the armature winding proper and seeing that the segments are marked (1′, 2′, 3′, etc.,) there is no need to show a commutator. Differing from all the a-c windings just mentioned in which the ends of each phase-winding are left free, the d-c winding is seen to close upon itself through a commutator segment. It is also seen that all the connections are unidirectional from pole to pole. The diagram for a single-phase a-c single-series, lap-connected winding would show direct coil-to-coil series connections per pole, and the pole-group connections would follow polarity arrow-heads, and the two phase-lead ends would remain free or open.

In this form of diagram we clearly visualize the distinction between whole-group coil connections of the d-c and a-c windings—connections being made unidirectional for the former and alternate for the latter. It shows that d-c coil-to-coil connections first pass to the segments. The diagram displays that there are as many electrically identical points for the brushes as there are pole pairs and that such positions occur on one vertical line. It shows that tappings for a 3-phase rotary converter may be made at the 180 deg position in pole 2 for phase A, the 60 deg position in pole 3 for phase B, and the 300 deg position in pole 4 for phase C; we see that the number of phase tappings for each slip-ring equals the number of pole pairs. A fully developed winding table extracted from Fig. 5, bottom left, reads:

T	B	T	B	T	B	T	B	T	B	T	B
- 1	7- 2′-	2	8- 3′- 3		9- 4′- 4		10- 5′- 5		11- 6′- 6		12- 7′-
- 7	13- 8′-	8	14- 9′- 9		15-10′-10		16-11′-11		17-12′- 6		18-13′-
-13	19-14′-	14	20-15′-15		21-16′-16		22-17′-17		23-18′-18		24-19′-
-19	1-20′-	20	2-21′-21		3-22′-22		4-23′-23		5-24′-24		6- 1′-

The vertical line of coil sides T1-7-13-19 are equi-potential positions and the vertical line of coil sides T1-13, 7-19 are electrically identical positions — these latter represent brush positions which cannot very well be mistaken in this form of diagram because they are situated on one vertical line.

This form of armature winding diagram reveals that each coil can be connected in two ways, it shows what happens; it shows that the voltages in the coil sides may be positive or negative according to their manner of connection, and one simple skeleton diagram shows how different balanced phase windings are obtained by locating and connecting coils in a variety of ways.

Fig. 6 shows a partially completed diagram for a 3-phase, 36-slot, 4-pole to 6-pole (also 6-pole to 4-pole) change without change of coil throw. The left and right polar diagrams show a 4 and 6 pole layout respectively, with shaded portions displaying the related field area of a polarity. Bottom right gives a straight line superimposed diagram of the 6 to 4 pole layout; lower part shows slots drawn in, the right side gives polarity, bottom gives phase belts of the 6-pole winding, and top end gives the phase belts of the 4-pole winding. Both graphic methods show that depth behind the slots is decreased with increase in the number of poles. They show underchording for a speed change from 4 to 6 poles and over-chording for a change from 6 to 4 poles. Assuming full-pitch coils in the 6-pole winding and reconnection to 4-poles (coil throw remaining unchanged) the winding of the latter becomes under-chorded by 2/3 or 66.6 per cent, with 120 deg pitch in place of 180 deg as shown previously.

Fig. 6 shows in skeleton form at the bottom left the same 4-pole layout divided into two equal halves and superimposed to visualize just how the electrically identical coil side positions coincide and why they can be tied in electrical parallel. Instead of superimposing as shown here (the two halves being slightly displaced for clarity), the single series layout shown on the right may be left undisturbed and the 2-parallel connections lengthened and "jumped" across the corresponding electrically-identical positions marked on the diagram. This straight line 2-parallel winding diagram is given here to prove that the principle is fundamental and applicable to any number of pole pairs or parallels such as a 2 and a 4-parallel for 8-poles. It illustrates why the con-

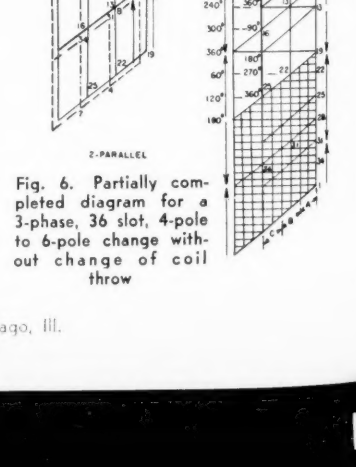


Fig. 6. Partially completed diagram for a 3-phase, 36 slot, 4-pole to 6-pole change without change of coil throw

nections per phase winding must be made at electrically identical coil side positions—there being two such positions in a 4-pole winding. Diagram shows that the field area is reduced to 4/6 or 2/3 for a change from 6 to 4 poles. The corresponding polar diagram would show the changed chord-factor as a result of changing the winding pitch. Winding table for the 4-pole, 3-phase, 2-parallel reconnection, extracted from Fig. 6 bottom left reads:

	0°	180°	240°	60°	120°	300°
A	-1	10-A′	B-31	4-B′	C -7	16-C′
	-19	28-	13	22-	25	34-
	360°	180°	240°	60°	120°	300°

This simplified skeleton diagram pictures all the pole-phase group positions and their electrical angular degree relations, which are the only coil-side positions required for parallel connection of lap windings.

QUESTIONS

1. Using Fig. 1 for reference, give the electrical angular degree covered by the respective phase zones A, B and C in the field commencing at slot 1.

Ans. Phase A is seen to cover the zone area from 0 deg to 60 deg; phase B covers that part from 60 deg to 120 deg; and phase C covers the remaining part from 120 deg to 180 deg, which latter is slot 7. (We thus see at a glance what phase or phases have been invaded.)

2. From Fig. 2 and the extracted winding table prove that this basket winding can be satisfactorily connected and operated in 2-parallel.

Ans. From the diagram merely ascertain that the connection positions are electrically identical; that is to say, for phase A, the 2-parallel connections are:

	1	10 - 3		12 - 5		14
A	0°	180°	40°	220°	80°	260° A′
	19	28 - 21		30 - 23		32

Do likewise for phase B and phase C. (We thus see the value of this form of diagram for spotting the true electrically identical and parallel connection positions.)

3. Show proof that the concentric winding of Fig. 3 can be connected in 2-parallel. (The solution of this problem is left to the reader—take the cue from Q. 2.)

4. Examine the mush winding shown in Fig. 4 and explain how the coil side in slot 14 of phase B invades phase A zone.

Ans. Due to the short-pitched coil which has a throw from 9(240 deg) to 14(30 deg), instead of 9(240 deg) to 15(60 deg) which is 240—60=180 deg, phase A zone is invaded. Thus, if a coil-side was placed in the top of slot 14, then the bottom coil side of phase B coil with throw from slot 9 to slot 14 would not only overlap phase A but the current would flow in opposite directions. (At a glance this form of diagram shows where, how much and what phase belts are overlapped.)

5. What is the rule for coil-to-coil and group-to-group connections of phase windings?

Ans. First examine the lap and wave windings in Figs. 4 and 5 of Part I, then the basket, concentric and mush windings of Part II. In every case it is seen that the connections follow polarity arrowheads, first by completing the coil-to-coil then the pole-phase group connections or series-four connections in the case of wave windings. (We thus see the value of this form of diagram for checking the accuracy of coil and group connections.)

6. Knowing that the commutator brushes are located at electrically identical positions, in what coil-side positions would you set the brushes for Fig. 5 lap winding?

Ans. The brush rocker arm may be moved so that the four brushes are in positions 1(T), 7(T), 13(T) and 19(T) all of which are on one straight vertical line. For a lap winding 1 and 13 are joined to form (say) the positive lead; 7 and 19 are joined to form (say) the negative lead. (Here again we see the practical advantage of this form of armature winding diagram.)

7. Considering two winding cores, a 4-pole and a 6-pole, state which core requires a greater depth of iron behind the slot teeth.

Ans. Fig. 6 top right and left, also bottom right, show that the 4-pole requires a greater depth of iron and consequently a greater magnetic field area than the 6-pole.

Editor's Note: This is the second of four articles on this subject by the author. A third, dealing with Chorded Windings will appear in a subsequent issue.

Trends In The Use Of New Equipment

The war program has brought about many important developments in material and design and has created many new and difficult applications. By successfully solving these problems, engineers are doing their bit to hasten the final day of victory

By H. R. Vaughan

Central Station Engineer, Westinghouse Electric & Mfg. Co.

DURING 1941 9000 miles of transmission circuits, 11 kv and above, were constructed in the United States. This represents almost a 100 per cent increase over construction in 1939. In addition 6,000,000 kva in substation capacity was added during the same year, an increase of more than 100 per cent over 1939. It is estimated that these figures at least were equaled in 1942. Add to these the amount of distribution apparatus installed last year or now on order for industrial plants, and it will be apparent that an enormous volume of transmission and distribution equipment has been manufactured and applied during the last two years.

It might seem that this tremendous load upon manufacturing and operating facilities would stalemate any new ideas in apparatus design and would prohibit any departure from conventional applications. Development work has been handicapped to some extent, but every effort is being made to adhere to standardization where at all possible. Nevertheless, the requirements of the war program actually fostered a number of new developments in apparatus design and application, and have had a very decided influence on the trends in the use of new equipment.

In many instances war plants have been constructed at points remote from sources of power supply. Therefore, to utilize existing power generation it has been necessary to construct numerous transmission line feeders as well as to install interconnections between systems. Since these transmission lines had to be constructed in the shortest possible time using a minimum amount of structural steel, the type of construction reflects the influence markedly. Wood pole lines have been used where steel towers would otherwise have been preferred. Single circuits now have to serve where double circuits normally were considered necessary.

Developments in Lightning Protection

Today of necessity larger blocks of power are transmitted over single circuit lines to many important loads. This has been made possible by recent developments covering lightning protection, fault clearing,

(*Continued on page* 118)

Conversion from Oil Firing to Coal Firing

Part 1

In view of present and possible future restrictions on the use of oil for fuel, many power plants are now being forced to convert to coal firing or may be forced to do so later. When they do, they should convert not in the cheapest way but in the soundest engineering way, making provision for both coal and oil firing, the former probably the permanent base fuel. From this point of view, conversion to pulverized coal offers many advantages, for a furnace for this method is also satisfactory for oil if it is ever competitively available. Even small units, of 160 hp capacity, have successfully burned pulverized coal. Hand firing of boilers above 150 hp is not recommended. Various types of stokers have been successfully applied to boilers up to 300,000 lb per hr capacity. The maximum for pulverized-coal firing is limited only by boiler and furnace. Heat release and ash fusion temperature determine design of pulverized-coal furnaces and curves are shown for relations between these and various operating factors. Part 1 discusses the foregoing in detail and gives an analysis of an actual installation. Part 2 will give details of a number of actual conversions using several methods of coal firing.

By Ollison Craig *Engineering Manager, Riley Stoker Corp.*

BECAUSE OF PRESENT restrictions in the use of fuel oil, especially along the Atlantic seaboard, plants burning this fuel either have changed to other fuels, have been ordered to change, or must face the possibility of such an order in the future. The situation during the remainder of the war may not improve but may become worse. Even in plants near the source of oil supply, the campaign for conversion may be extended.

There is considerable speculation about availability of oil after the war. Certainly oil is too valuable to be used merely as a fuel. Hence the Government may establish a program of conservation when the present oil emergency is over. Accordingly, it might be good judgment, in converting from oil, to consider coal firing the permanent method, with oil used only as a standby. At present many plants seem to be making the cheapest conversions possible, without considering their post-war situations.

If the above surmises are correct, plants that change to coal firing last will have the most difficulties in regard to coal supply. Coal operators, obviously, are going to give first choice of coal to older customers. Because of increased demands, coal operators are under greater pressure, hence coal is not as well cleaned as formerly and marginal mines, often strip mines, are being opened. Presumably the later a plant arranges for its coal supply, the worse the grade of coal it can expect to get—coal higher in ash, lower in ash fusion temperature, lower in heat value—requiring more expensive changes and more expensive equipment than otherwise.

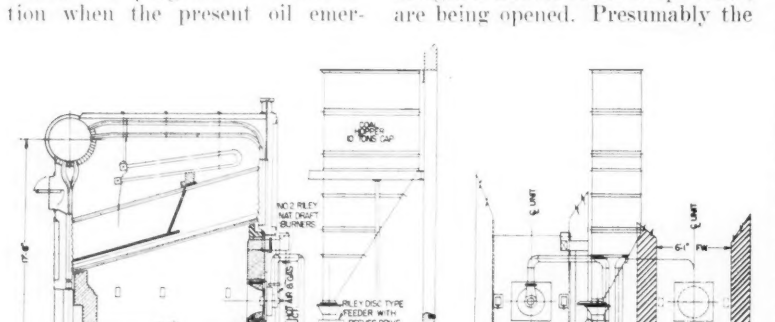

NO.2 RILEY NAT. DRAFT BURNERS
RILEY DISC TYPE FEEDER WITH REEVES DRIVE
FORMER OIL FIRING FURNACE FLOOR
OPERATING FLOOR
NO.2 RILEY ATRITA UNIT PULVERIZER
BASEMENT FLOOR
SIDE ELEVATION
FRONT VIEW & SECTION

Fig. 1. Even small units can be converted to pulverized coal. These two 160-hp boilers, formerly oil-fired, now fired with coal from a single pulverizer

How Make the Change?

When a plant has decided to convert to coal, how shall the change be made? Hand firing is obviously the least efficient method, in any case should be limited to the physical capacity of the fireman. Usually it is not advisable to hand-fire boilers larger than 150 rated horsepower. In this article, hand firing will be ignored, since in no case would it be recommended. There remain stoker firing and pulverized-coal firing.[1]

Single or twin-retort side-dump stokers should be limited to boilers having a maximum output of 25,000 to 30,000 lb of steam an hour. Multiple-retort stokers may be applied to boilers up to about 300,000 lb of steam an hour capacity. Traveling grate stokers have been applied to boilers of 200,000

[1]Underfeed stokers—single or twin retort with side dumps or multiple retort with end dumps—are suitable for most bituminous and sub-bituminous coals. Traveling grate stokers are suitable for free-burning bituminous and sub-bituminous coals, lignites, anthracite and coke breeze. Traveling grate stokers are not suitable for caking coals as are underfeed stokers. Difficulty may even be experienced in using underfeed stokers with badly caking coals if the furnace should be too cold. Spreader stokers are suitable for most bituminous and sub-bituminous coals. Pulverizers are suitable for any bituminous or sub-bituminous coals but not for anthracite or coke breeze. Suitability of pulverizers for lignite has not yet been fully determined.

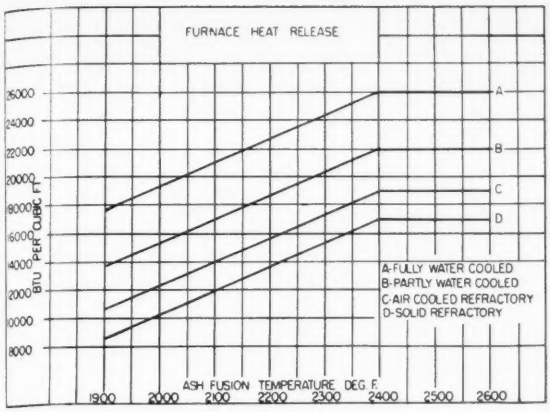


Fig. 2. (Above) Reasonable rates of heat release for four types of furnaces. Curve "A", fully water-cooled, water tubes closely spaced on all four walls and on furnace bottom. Curve "B", partly water-cooled, water tubes only on rear wall or quite widely spaced on side walls. Curve "C", refractory, with structurally supported air-cooled walls. Curve "D", furnace with entirely solid refractory walls

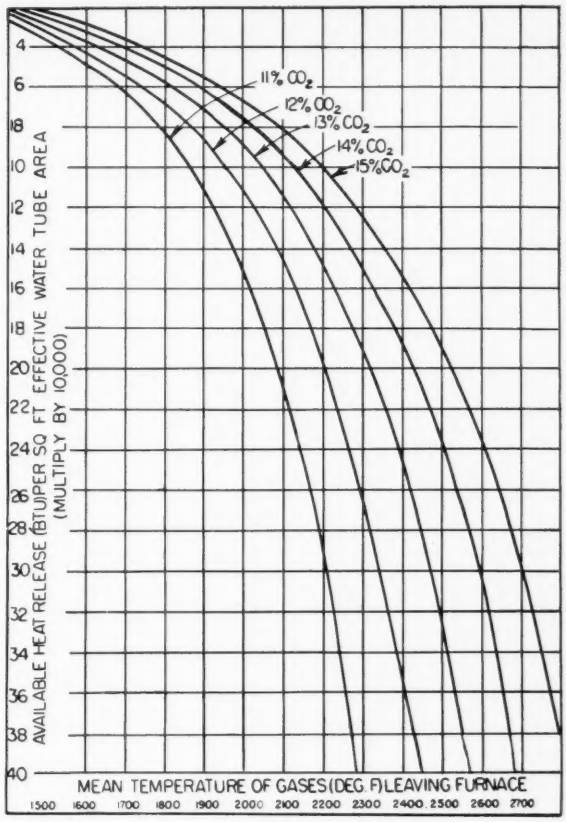


Fig. 3. (Right) Curves showing variation in furnace temperature with heat release per square foot tube area exposed and CO_2. Each curve is for constant percentage of CO_2 or constant percentages of excess air. If rate of heat release is small, large change in temperature is obtained with small change in heat absorbing surface. At high rates of heat release, curves are quite steep, indicate considerable change in radiant heat absorption area for small change in temperature

lb of steam an hour and spreader stokers have also been applied to boilers of 200,000 lb of steam an hour capacity. These figures represent largely present-day practice and probably also represent the practical limit of application. With pulverized-coal firing, the only limit of capacity is the design of the boiler and furnace unit.

Pulverized Coal Offers Conversion Advantages

It may also be safely said that higher average efficiency will be obtained burning coal in pulverized form than on any form of stoker. This difference in efficiency will pay for the greater power requirements of pulverized-coal firing and return an appreciable net saving to the plant. Load swings can be carried with little or no effect on furnace conditions while such swings might seriously upset stoker fuel bed conditions. Much better control of CO_2 in furnace gases is possible, since it is only necessary to maintain proper fuel-air ratio. In stoker firing, holes or clinkers in the fuel bed can radically change the CO_2 in the furnace gases. To correct such conditions requires considerable time.

The most conclusive argument for the use of pulverized coal when changing from oil firing is the fact that a furnace properly designed for pulverized-coal firing is also suitable for firing oil and obtaining equal or greater steam capacity. Because of the uncertainties of the post-war outlook, it would seem good judgment to make changes in equipment that will permit either coal or oil to be burned.

How Small A Boiler Can Burn Pulverized Coal?

There is no question about the maximum capacity of a boiler unit that can be equipped for pulverized-coal firing. There is, however, a great difference of opinion as to how small a boiler may be and still justify such firing. Many boilers being successfully fired with pulverized coal are much smaller in capacity than is generally accepted as the minimum.

Figure 1 illustrates one such case. Illustrated are two straight-tube, water-tube boilers, each of a rated capacity of 160 hp, previously fired with oil. During the period of oil firing, the bottom of the furnace floor was at the operating floor level. In changing to coal firing, the floor under the furnace was removed and the furnace extended down to the basement floor by brick walls set within the beams supporting the original furnace wall. The cross-sectional area of that space in the furnace below the operating floor is less than the cross-sectional area above the operating floor. The furnaces are entirely refractory.

One small pulverizer was installed, discharging through a splitting valve, which divides the coal into two streams, each stream going to one burner in the front wall of each furnace. Maximum capacity of the two boilers together is 15,000 lb of steam an hour. All the advantages of pulverized-coal firing were obtained but the expense of installation was kept to a minimum by installing one pulverizer for the two boilers. Since there is only one pulverizer, stand-by service is obtained from the existing oil equipment. Oil is kept hot and circulating. In case coal becomes unavailable for any reason, the load can be picked up by oil in less than one minute.

Coal Characteristics Affect Pulverizer Selection

In selecting pulverizers, the purchaser should advise the manufacturer, not only of the amount, pressure and temperature of steam produced, but also of the specifications of the worst coal he may be forced to use. Use of coal having lower Btu value will necessitate pulverizing and burning more pounds of coal, hence pulverizers

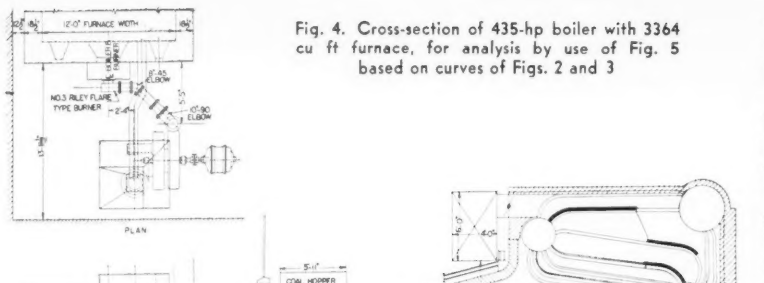


Fig. 4. Cross-section of 435-hp boiler with 3364 cu ft furnace, for analysis by use of Fig. 5 based on curves of Figs. 2 and 3

must be larger. Pulverizer capacity is also affected by grindability, or hardness, of coal and by the percentage of free moisture it contains. The manufacturer[2] must know all these things to make an intelligent selection.

Heat Release and Furnace Design

The pulverized-coal equipment is a very small factor in determining furnace size in comparison with two other important considerations: the kind of furnace walls and the ash fusion temperature of the coal. The size of a particular furnace is determined by the heat release in Btu per cubic foot per hour. In general, the lower the temperature at which the ash in the coal fuses, the lower the suitable heat release. It is also permitted for any given coal to operate at higher rates of heat release if furnaces are provided with extensive water cooling by means of water tubes properly disposed on the furnace walls and furnace bottom.

Reasonable and conservative rates of heat release for four classes of furnace construction are shown in Fig. 2. The curves slope upward to an ash fusion temperature of 2400 F and are then horizontal at higher temperatures. The rates of heat release indicated by these curves at the 2400-deg point are such that if the higher rates were used with higher fusion temperatures, the flame would fill the furnace so that impingement would occur on the walls and slag would deposit regardless of any other considerations. Maximum rates of heat release indicated on these curves are those which experience has shown to be reasonably conservative and trouble-free. Considerably higher rates have been used than the maximum of 26,000 shown. Serious trouble, however, has been encountered. If a design is based on the rates indicated on the curves, good operation can be obtained; if the rates are materially higher, trouble can be expected.

Furnace and Ash Fusion Temperatures

Furnace temperatures should be kept at such a level that trouble will not be experienced due to fusion of ash. If a furnace is fired at a given rate and with a given percentage of excess air, and if the furnace walls are entirely refractory, the temperature of gases in the furnace will be higher than if the walls were water-cooled. The temperature in the furnace, then, is a function of the amount of heat released in relation to the water-cooled area of the tubes exposed and the percentage of excess air.

Figure 3 shows a group of curves indicating how these temperatures vary for a given amount of heat release per square foot of tube area exposed and for a given percentage of CO_2.

How to Use the Curves

Use of such curves is illustrated by an actual installation, Fig. 4. The boiler is rated at 435 hp. The furnace is entirely refractory with structurally-supported, air-cooled walls. Tube area exposed to radiation from the furnace is 150 sq ft. The furnace volume is 3364 cu ft. The length of the furnace is 19

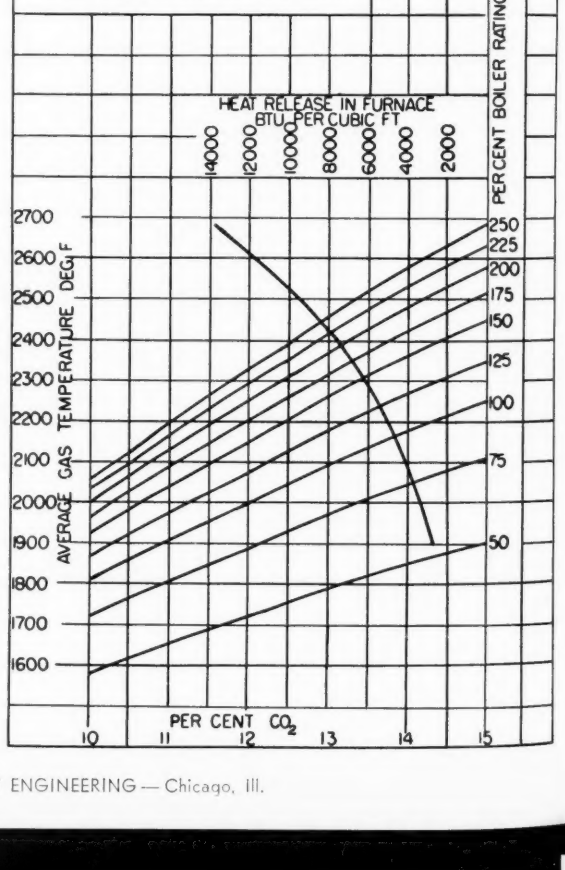


Fig. 5. Curves of furnace temperatures, CO_2, boiler rating and furnace heat release developed by methods of Figs. 2 and 3 and applied to boiler of Fig. 4. Upward curves are each for constant per cent of boiler rating

[2]It is quite common for purchasers to state that equipment shall be furnished suitable for the coals entering a particular market. This throws the burden of guessing on the manufacturer, with the result that the purchaser may be badly penalized. If the manufacturer selects equipment on the basis of the better grades of coal available, then the purchaser may lack steam capacity if compelled to use lower grade coals. In any case, it is very desirable to obtain propositions on pulverized-coal equipment on the basis of specific and precise coal specifications, since the purchaser will then be assured that all manufacturers are bidding on the same basis.

ft, width is 12 ft, mean height is about 15 ft. The furnace floor is flat and has an area 12 ft wide by 19 ft long.

In Fig. 5 are a series of curves developed for this boiler from curves similar to those in Fig. 2. This group of curves represents relations between percentage of CO_2 in the furnace gases and the average temperatures of the gases in the furnace. An additional curve represents the relation between boiler rating and furnace heat release.

The boiler was installed for a maximum capacity of 250 per cent of rating. At this capacity the heat release in the furnace is approximately 14,000 Btu per cubic foot. Referring to Fig. 2, Curve "C," a heat release of 14,000 is permissible with coal having ash fusion temperature of 2100 F. Coal obtained by this plant in the past has in general been of a higher grade but the boiler has also operated at rates higher than 250 per cent.

Experience with the boiler has indicated that the values shown by Fig. 5 are reasonably correct. They indicate that 250 per cent of rating can be obtained with 15 per cent CO_2 in the furnace gases if the ash fusion temperature is not lower than 2680 F. If the plant should be required to use a coal having an ash fusion temperature of, say, 2300 F, this could be done by reducing the CO_2 to about 11.8 per cent. At 10 per cent CO_2 this 250 per cent capacity could be carried with coal having an ash fusion temperature of 2060 F.

Curves Show Performance with Lower Grade Coal

With an installation such as this, a series of curves, such as that in Fig. 5, can be used to predict obtainable capacity if the plant must use a lower grade coal than was customary. If furnace temperatures, shown in Figs. 3 and 5, are not greater than the temperature of ash fusion, no unreasonable slagging trouble will be experienced.

With a given installation, if coal having a low ash fusion temperature was received, and if it was found that, in order to keep down furnace temperatures by the use of excess air, the capacity of the forced draft fan was exceeded, then such curves would indicate what capacity could be obtained from the boiler with the amount of air available from the fan.

(To be continued)

"Electrical Weatherman" Guards War Production

INVENTION of a new tool to reduce spoilage of war machine parts, an electronic "weatherman" that discovers moisture in gases 1,000 times as dry as outdoor air on an average sunny day, has been developed by Westinghouse Research Laboratories.

Essential part of the new "electrical meteorologist"—called an automatic dew-point recorder—is an electronic tube. Importance of this product of electronic research lies in its ability to discover as little as four thousandths of one per cent water vapor in furnace gases used to heat-harden tough steel airplane, tank and gun parts.

Recorder Indicates Moisture in Furnace Gases

The recorder does its forecasting by indicating the exact moment the furnace gases become too wet. This close check is imperative since the flow of wet gas to a furnace for only a few minutes might ruin a whole batch of carefully machined parts by softening and rusting their surfaces. Softening is caused when oxygen in the wet gas combines with the steel's carbon—its hardening agent.

Moisture in heat-treating furnace gases is now measured by inserting a cold, polished metal surface in the gas stream and observing the temperature at which a mist-like film of water forms on the polished metal. From this temperature, a skilled technician calculates the water content of the gas, a method that is accurate only within eight or ten degrees at low temperatures, and requires ten minutes of the technician's time at least once an hour.

Accurate to One Degree

The new electronic recorder is accurate within one degree of temperature and, since it is automatic, frees the technician for other work. It records its discoveries on a meter which can be read by even an unskilled workman.

All steel machine parts that must withstand wear require hardening in heat-treating furnaces through which such gases as hydrogen are forced to exclude air. This is necessary because air ordinarily contains 20 per cent oxygen—enough to rob hot steel of carbon needed in the hardening process—and sufficient moisture to rust steel at high temperature.

Even with this technique, however, moisture cannot be entirely excluded from the furnaces since traces of oxygen present in the gases combine with the hydrogen to form water vapor. To overcome this obstacle, blotter-like drying agents such as aluminum hydroxide are placed in tanks throughout which the gases flow on their way to the furnaces.

Electrons Do the Job

The dew-point recorder tells when the gases need such drying, and it also tells when a drying tank becomes saturated and will absorb no more moisture. The furnace gases must be then routed to a new drying tank.

Contents of the recorder's tube are similar to a radio rectifier tube, which is used to transform alternating current electricity to direct current. But the radio tube contains no gases, whereas gas from the heat treating furnace flows continuously through the recorder's tube.

Philip R. Kalischer who developed the device explains that electrons (negatively charged electrical particles) travel from the tube's hot filament to a metal plate. As long as dry gas passes through the tube, electrons flow steadily, producing an unvarying electric current in an external wire circuit. But when water vapor is present in the gas, some of the electrons adhere to the water's oxygen atoms, reducing the electric current. By measuring the flow of current, a meter indicates the moisture in the gas.

The new recorder has several advantages over the present method. It is more accurate, it is automatic and everyone who can read a meter can operate it.

Modernized Firing Methods in Powder Plant

Coal fed directly and automatically from boiler room bin to underfeed stoker replaced hand firing in Egyptian Powder Co. plant with 22.5 per cent saving in fuel cost due to increased efficiency and use of cheaper coal. Steaming capacity now provides spare boiler

By T. A. MARSH

BLACK POWDER is one of the essential supplies used in mining bituminous coal. It is therefore logical that the plant of the Egyptian Powder Co., one of the large black powder plants of the country should be located at Herrin, Ill., adjacent to the rich and productive "Quality Circle" group of Southern Illinois coal mines.

In common with most plants manufacturing similar products, a wide acreage is enclosed and the manufacturing processes of grinding ingredients, mixing and drying are disseminated in isolated buildings.

Manufacturing operations are carried on currently to meet customer requirements without carrying an excess inventory of finished products beyond that required to fill orders promptly.

The process of manufacture involves power for grinding, mixing, and other uses, also steam for drying and for heating.

Equipment

The power plant consists essentially of:

1 Erie City 18 by 21 in. horizontal engine, directly connected to Westinghouse 170-kw, 250 v, d-c electric generator.

1 Chuse 18 by 20 in. horizontal engine, directly connected to General Electric 150-kw, 250 v, d-c generator.

Steam is supplied by:

4 boilers each 72 in. by 18 ft hrt with 1400 sq ft of heating surface.

Height of boilers floor to shell is 72 in.

Total combustion volume is 490 cu ft.

Initially, the boilers were fired by hand as shown in Fig. 1, using hand-fired coal sizes ranging from 6 in. by 0 to 1½ in. by 0 from the nearby Quality Circle Mines. This method, however, has been changed to underfeed stoker firing as shown in Fig. 2 which is a transverse section showing the general arrangement and proportions of boilers, combustion chambers, and stokers. A coal bunker having about 75 tons capacity extends the full length of the boiler room, its retaining wall being 10 ft 4 in. from the boiler fronts. Coal is delivered by railroad cars and elevated and conveyed to the bunker by means of a portable conveyor.

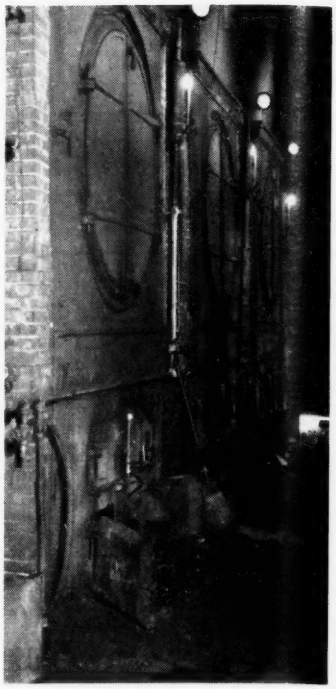


Fig. 1. Boiler room conditions under hand firing methods formerly employed in black powder plant

The four stokers are Iron Fireman, size No. 5, Type CLC which is the bin feed design, drawing coal directly from the coal bunker and delivering it to the furnaces without manual handling and without separate coal handling equipment within the boiler room. This equipment is shown in Figs. 3 and 4.

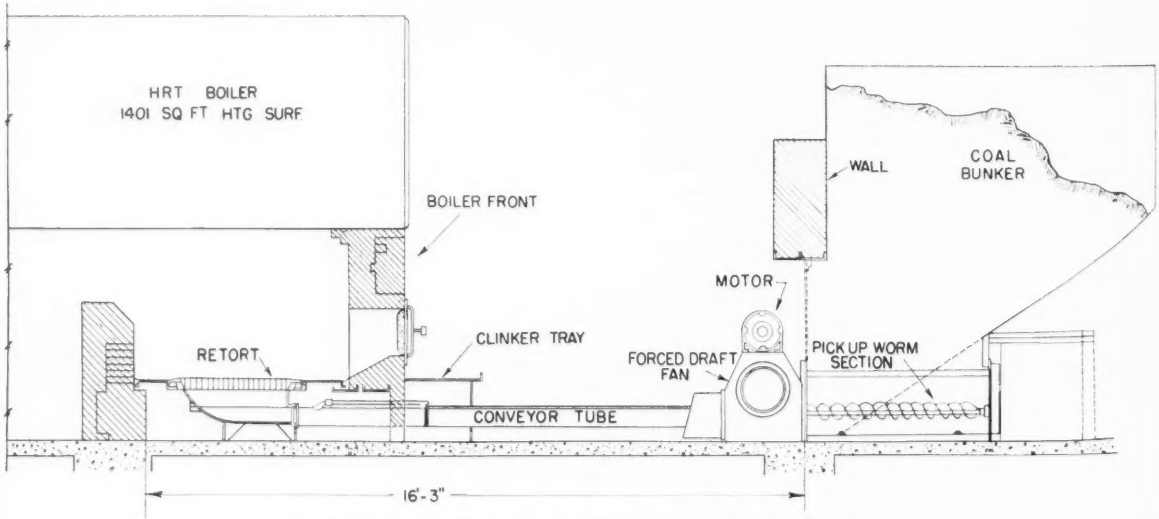


Fig. 2. Stoker installation arrangement at Egyptian Powder Co. plant

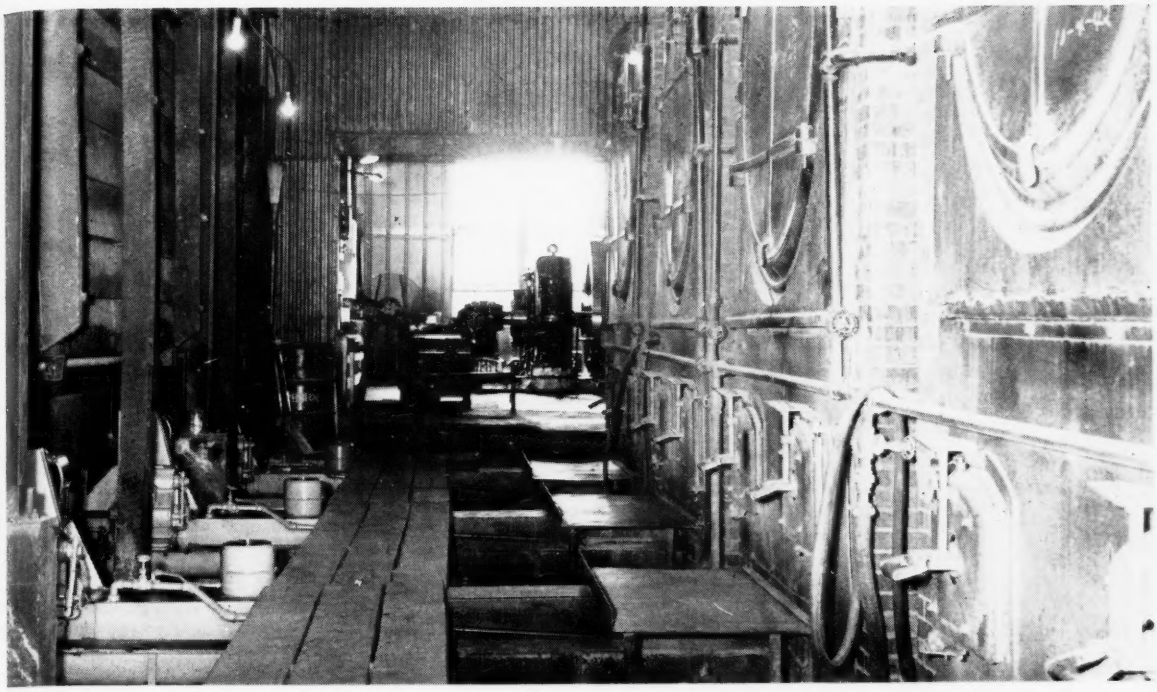


Fig. 3. View of stoker installation while construction was in progress

Approximately 300,000 lb of steam are generated each 24 hr of operation and the plant schedule is 20 days per month. The engines, which are noncondensing, use 75 per cent of the steam generated, the exhaust being used for drying, augmented by the use of live steam as required. Buildings near the power house are heated by exhaust steam from the engines.

Owing to the long distance from the power house to points of steam utilization and the fact that these are scattered over a considerable acreage, no condensate is returned to the power house. Boiler feed is supplied from artificial lakes.

Iron Fireman stokers were installed in the summer of 1941 with the following objectives:

1. Reduction in fuel costs due to higher efficiency and lower priced coal.

2. By the use of bin feed stokers without manual coal handling, the avoidance of the necessity of increasing the power house force due to expanded operations.

3. Providing of a "spare" boiler for plant reliability. All four boilers were required in operation when hand fired.

4. The maintenance of uniform steam pressure for engine operation.

All of these objectives were attained by the Egyptian Powder Co. Fuel savings per unit of finished product are indicated at 22.5 per cent as compared to the operation before installing the stokers.

With expanded operations, no additional labor has been required.

The load can be comfortably carried on three boilers, thus providing a spare unit, and uniform steam pressure is readily maintained.

Credit for this conversion and the results accomplished accrues to R. C. Faris, Engineer, East Alton, Ill., and to S. V. Aikman, resident manager at Herrin, Ill.

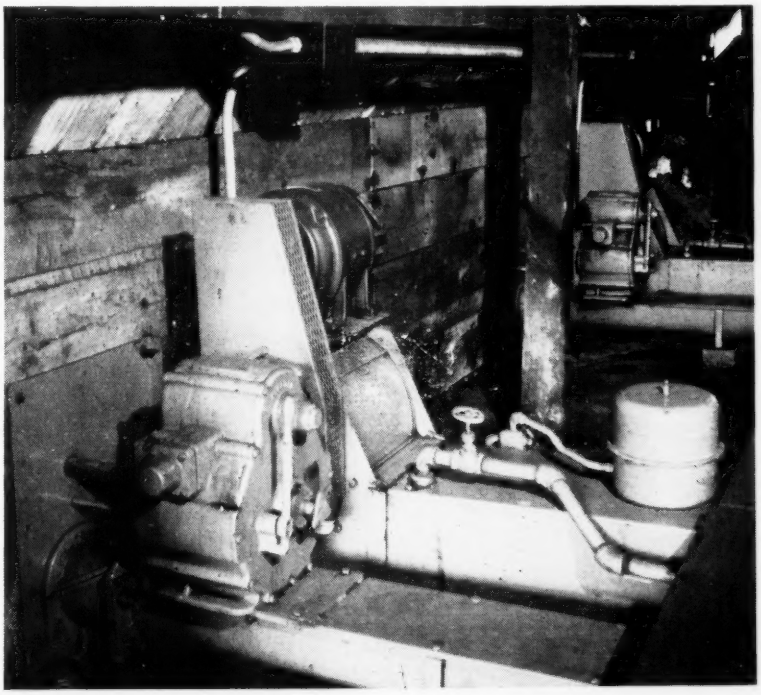


Fig. 4. Close up view of stoker drive and forced draft fan installed on the coal bunker side of the firing aisle giving fireman plenty of room for removal of clinkers

Predictable Results From Use of Carbonaceous

Acid-Regenerated Zeolites

By a series of tests the authors have determined that the effluent of a hydrogen zeolite unit before exhaustion may vary from below 40 to 98 per cent of the theoretical acidity equivalent to the sulphate and chloride content. This article explains this variation and shows how such variations can be predicted. The conclusion is drawn that it is no longer necessary to depend upon an average coefficient of exchange in predicting the performance of an acid regenerated carbonaceous zeolite unit, but the characteristics of the effluent can be predicted precisely from an accurate analysis of the raw water and knowledge of the quality of the carbonaceous zeolite. In the present investigation two varieties of carbonaceous zeolites were tested, with identical results, and it is quite likely that the same characteristics will be found in other varieties. With such data, equipment can be designed for accurate results

By FRANK KEMMER and JOSEPH THOMPSON Cochrane Corporation Laboratories

ACID REGENERATED carbonaceous zeolites serve two functions in water conditioning practice: they accomplish removal of hardness and reduction of solids and alkalinity, as illustrated by the following chemical reactions:

1—*Removal of Hardness*

(a) $\begin{matrix}CaSO_4\\MgCl_2\end{matrix}\Big\} + 2H_2Z^* \rightarrow \begin{matrix}Ca\\Mg\end{matrix}\Big\} Z + \begin{matrix}H_2SO_4\\2HCl\end{matrix}$

Theoretically, all salts of calcium, magnesium and sodium react in this manner, and when the total flow is kept within the limits of the capacity of the zeolite bed, the amount of hardness in the effluent will be from 0.0 to 5.0 ppm, expressed as calcium carbonate.

2—*Reduction of Alkalinity and Solids*

(b) $\begin{matrix}Ca(HCO_3)_2\\Mg(HCO_3)_2\\2NaHCO_3\end{matrix}\Big\} + 3H_2Z \rightarrow \begin{matrix}Ca\\Mg\\Na_2\end{matrix}\Big\} Z + 6H_2CO_3$

(c) $6H_2CO_3 \rightarrow 6CO_2\uparrow + 6H_2O$

The bicarbonates (alkalinity) are converted to the equivalent quantities of carbonic acid, which is removed from the treated water by aeration by passing the water through a decarbonator (Reaction (c)).

It is obvious that the reduction in total solids is equivalent to the reduction in bicarbonates in the raw water.

Reactions (a) indicate that the effluent water contains mineral acidity (sulphuric and hydrochloric acids) theoretically equivalent to the sulphate and chloride contents of the raw water. This must be neutralized, and an excess of alkalinity can be maintained by any one of three methods:

*Carbonaceous zeolites are complex organic compounds and, as a matter of convenience, the letter Z is used to represent the compound. H_2Z, CaZ, MgZ, Na_2Z are merely convenient designations of the zeolite material combined with hydrogen, calcium, magnesium and sodium, respectively, and are not in any sense chemical formulas.

(1) The acid effluent may be neutralized by blending it with effluent from zeolite regenerated by brine (sodium chloride), the residual alkalinity depending upon the ratio of the blend and upon the concentrations of acid and alkali in the respective effluents.

The manner in which alkali is produced by a brine regenerated zeolite is illustrated by the following chemical reactions:

(d) $\begin{matrix}Ca(HCO_3)_2\\Mg(HCO_3)_2\end{matrix}\Big\} + 2Na_2Z \rightarrow \begin{matrix}Ca\\Mg\end{matrix}\Big\} Z + 4NaHCO_3$

Part of the $NaHCO_3$ produced by (d) is neutralized by the mineral acid from Reactions (a) as follows:

(e) $\begin{matrix}H_2SO_4\\2HCl\end{matrix} + 4NaHCO_3(\text{plus excess}) \rightarrow$

$\begin{matrix}Na_2SO_4\\2NaCl\end{matrix} + 4H_2CO_3 + NaHCO_3\ (\text{excess})$

(2) The acid effluent may be blended with a raw water which is high in alkalinity and very low in hardness. Such a water contains sodium bicarbonate, so that the neutralization is according to Reaction (e).

(3) An alkali, such as caustic soda, sodium carbonate (soda ash) or trisodium phosphate, is fed to the acid water in quantity sufficient to neutralize the acidity and to provide the desired excess alkalinity. The reaction with caustic soda, for example, is as follows:

This method is practicable with waters high in calcium and magnesium bicarbonates and very low in sulphates and chlorides.

(f) $\begin{matrix}H_2SO_4\\2HCl\end{matrix} + 4NaOH \rightarrow \begin{matrix}Na_2SO_4\\2NaCl\end{matrix} + 4H_2O$

The most commonly used method of neutralizing the acidity in water from an H_2Z unit is by blending it with alkaline water from an Na_2Z unit, the general arrangement of the equipment being illustrated in Fig. 1. Figure 2 shows a commercial installation. In this apparatus the ratio of H_2Z effluent to Na_2Z effluent is maintained constant by automatic control devices, irrespective of variations in rate of flow of the blended water.

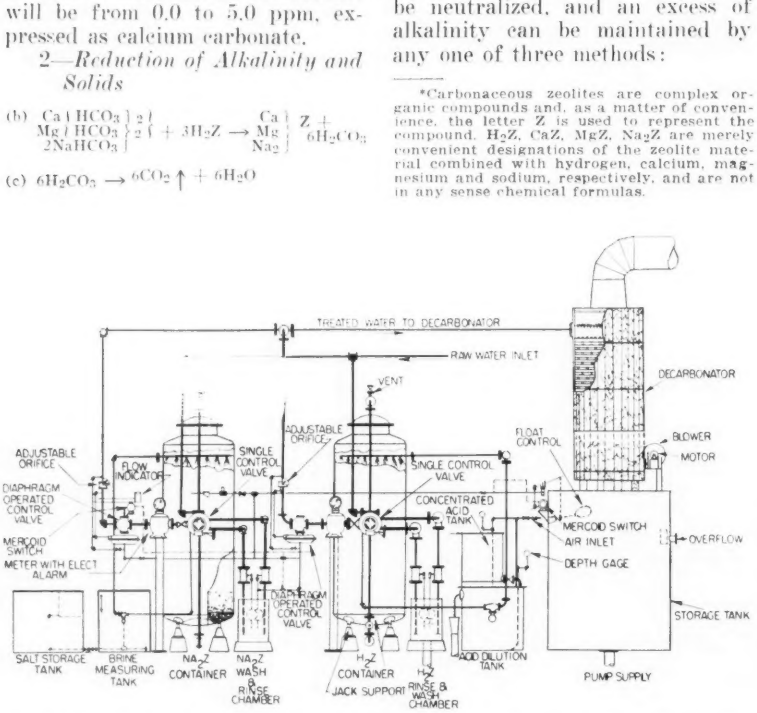


Fig. 1. Combination of acid regenerated and sodium regenerated softeners with blending and safety controls and with decarbonator for removal of CO_2

In the design of commercial equipment the size of the Na_2Z and of the H_2Z units are determined by first establishing the ratio of H_2Z effluent to total effluent by means of the following formula:

Formula 1—

$$H_2Z = \frac{A_R - A_B}{A_R + (SO_4 + Cl)\ 0.88}$$

$$Na_2Z = 1.0 - H_2Z$$

in which

H_2Z = fraction of total blend required from acid regenerated unit.

Na_2Z = fraction of total blend required from brine regenerated unit.

A_R = Total alkalinity of raw water, in terms of calcium carbonate ($CaCO_3$).

A_B = Desired alkalinity of blend, in terms of calcium carbonate.

SO_4 = Sulphate content of raw water, in terms of calcium carbonate.

Cl = Chloride content of raw water in terms of calcium carbonate.

The factor 0.88 represents the ratio of the expected mineral acidity to the theoretical mineral acidity of the effluent from the acid regenerated unit. (Reactions (a).) This is an average figure which for the normal water supply is satisfactory for design purposes and indicates that the average mineral acidity is 88 per cent of the theoretical.

Published quantitative data relating to the exact nature of the processed water is meager, and little information is available as to the influence of the mineral characteristics of the water on the exchange capacity of the zeolite and as to changes in the character of the effluent water during the process between regenerations. The character of the effluent is usually predicted on the basis of the anions (chlorides and sulphates) present, without consideration of the cations (calcium, magnesium and sodium).

As a typical illustration, one commercial zeolite is rated as having a capacity of 6500 grains per cu ft when regenerated with a specified quantity of acid, whereas the exchange capacity actually varies from 6500 to over 10,000 grains per cu ft, depending upon the mineral characteristics of the water treated.

The average mineral acidity of the effluent of an H_2Z unit before exhaustion may vary from below 40 per cent to 98 per cent of the theoretical acidity equivalent to the sulphate and chloride contents. The purpose of this paper is to explain this variation and to show how such variation can be predicted from an accurate analysis of the water to be treated. Formula (1) cannot be applied universally, but should be modified for water supplies that have unusual characteristics. Only when the exact quantity of mineral acidity produced by the acid regenerated zeolite is known, as well as the changing acid characteristics during the run, can a compensating change be made in the blend, in order to proportion accurately the effluent from a Na_2Z softener to the effluent from an H_2Z unit.

Experimental Investigation

To determine these relations, single salts and combinations of salts were passed through a zeolite bed and the characteristics of the effluent determined, the resulting data permitting accurate prediction of the chemical character of the effluent in any particular case, and, therefore, permitting intelligent control of blending. The carbonaceous zeolites used in this investigation were materials commercially offered for industrial use.

The zeolite beds were supported on graded anthracite and were contained in glass tubes 1 in. in diameter. Each bed was 12 in. in depth (measured wet after backwashing), and was regenerated with 1 per cent sulphuric acid solution at a rate of one gallon per minute per square foot of bed area. The quantity of reagent, following commercial practice, was 2 lb of 66 deg Bé sulphuric acid per cubic foot of zeolite.

Each water sample used in the experiments contained salts equivalent to 10 grains per gallon, expressed as calcium carbonate. Prior to regeneration, the beds were back-washed with Philadelphia city water for five minutes at a rate sufficient to expand the bed 100 per cent, ridding it of sediment, foreign material and trapped gases. Following regeneration, the zeolite beds were rinsed with distilled water until the effluent titrated zero hardness by the soap test and zero acidity. The softening rate of two gallons per square foot per minute was chosen because of the shallowness of the beds. The effluent was analyzed by—

(1) Titrating of 100 ml sample to the methyl orange endpoint with 0.07 normal caustic soda (NaOH).

(2) Determination of hardness by the American Public Health Association soap test.

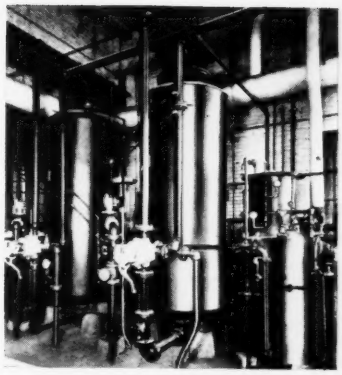


Fig. 2. Carbonaceous zeolite water softening equipment used for preparation of makeup for 600 psi boiler in an industrial plant

(3) Determination of sulphates and chlorides by usual laboratory methods.

When the effluent hardness exceeded 5 ppm in terms of calcium carbonate, the zeolite beds were considered to be exhausted.

Definition of Terms

For the purpose of discussion, the following terms are defined:

EXCHANGE CAPACITY: The hydrogen ion expressed as grains of calcium carbonate given up by 1 cu ft of zeolite during that part of the exchange cycle during which the effluent hardness is less than 5 ppm, expressed as calcium carbonate.

THEORETICAL ACIDITY: Chlorides, sulphates, nitrates and bicarbonates in the influent expressed as grains per gallon of calcium carbonate.

AVERAGE ACIDITY: Exchange capacity divided by the number of gallons softened per cu ft of zeolite.

THEORETICAL MINERAL ACIDITY: Chlorides, sulphates and nitrates expressed in terms of grains per gallon as calcium carbonate.

AVERAGE MINERAL ACIDITY: The average acidity due to the hydrogen ion titrated to the methyl orange endpoint expressed as grains per gallon as calcium carbonate.

CRITICAL POINT: Per cent of total run at which titrated acidity of the effluent drops appreciably below theoretical acidity.

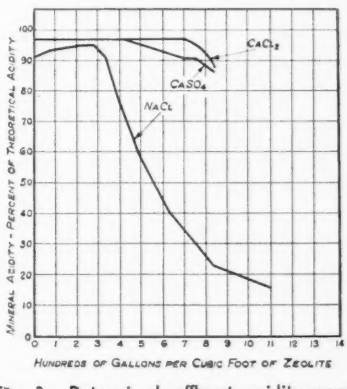


Fig. 3. Determined effluent acidity compared with theoretical mineral acidity

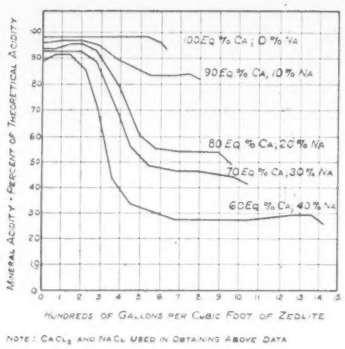

100 EQ % CA ; 0 % NA
90 EQ % CA, 10 % NA
80 EQ % CA, 20 % NA
70 EQ % CA, 30 % NA
60 EQ % CA, 40 % NA
MINERAL ACIDITY : PERCENT OF THEORETICAL ACIDITY
HUNDREDS OF GALLONS PER CUBIC FOOT OF ZEOLITE
NOTE : CaCl2 AND NaCl USED IN OBTAINING ABOVE DATA

Fig. 4. Results obtained with mixture of salts in water

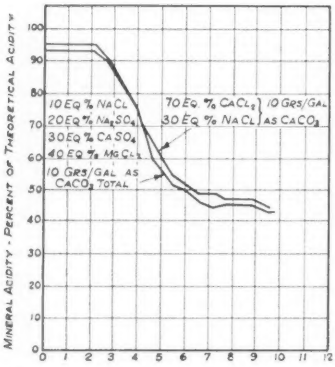

10 EQ % NaCl
20 EQ % Na2SO4
30 EQ % CaSO4
40 EQ % MgCl2
10 GRS/GAL AS CaCO3 TOTAL
70 EQ % CaCl2
30 EQ % NaCl
10 GRS/GAL AS CaCO3
MINERAL ACIDITY : PERCENT OF THEORETICAL ACIDITY
HUNDREDS OF GALLONS PER CUBIC FOOT OF ZEOLITE

Fig. 5. Results obtained when sulphate was substituted for chloride and magnesium for calcium were identical with those illustrated in Fig. 4

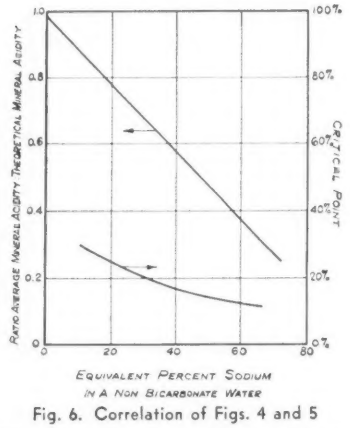

RATIO AVERAGE MINERAL ACIDITY : THEORETICAL MINERAL ACIDITY
CRITICAL POINT
EQUIVALENT PERCENT SODIUM
IN A NON BICARBONATE WATER

Fig. 6. Correlation of Figs. 4 and 5

Characteristics of Hydrogen Zeolite Effluent with Reference to Acidity and Exchange Capacity—Single Salts

Figure 3 shows how the effluent acidity as determined by this investigation compares with the theoretical mineral acidity when three water samples containing, respectively, single salts of calcium chloride, calcium sulphate and sodium chloride, are passed through the zeolite bed. The curve obtained for calcium chloride is characteristic of the results obtained with magnesium sulphate, magnesium chloride and all bicarbonate salts, that is, the average acidity is approximately 98 per cent of the theoretical acidity.

With bicarbonates the effluent acidity differs from the theoretical acidity only to the extent of the residual hardness present in the effluent.

The calcium sulphate curve is of interest because the average acidity is less than 98 per cent of the theoretical acidity, that is, the titrated acidity of the effluent decreases when the cycle is only 50 per cent complete, although no hardness is present in the effluent as indicated by the soap test and the sulphate content of the effluent is equal to that of the influent.

The sodium chloride curve, which is similar in all respects to that obtained for sodium sulphate, shows that the sodium ion is not as completely exchanged for hydrogen as is calcium or magnesium, even at the beginning of the cycle, and the average acidity is a lower percentage of the theoretical acidity than is the case for calcium or magnesium salts.

Generally speaking, calcium and magnesium salts react the same, whereas the sodium salts have considerably lower exchange capacity. There is relatively little difference between the effects of the chloride and of the sulphate, but of the three acid radicals (anions) the bicarbonate ion causes the greatest exchange of the cation.

Table I shows the exchange capacity determined for each water containing a single salt present in a quantity equivalent to 10 grains per gallon expressed as calcium carbonate. The effect of the various salts on the exchange capacity becomes obvious from this table.

Table I. Exchange capacities of salts

Salt		Exchange Capacity
Calcium bicarbonate	$Ca(HCO_3)_2$	10.5
Calcium sulphate	$CaSO_4$	6.0
Calcium chloride	$CaCl_2$	6.0
Magnesium bicarbonate	$Mg(HCO_3)_2$	10.3
Magnesium sulphate	$MgSO_4$	6.7
Magnesium chloride	$MgCl_2$	5.9
Sodium bicarbonate	$NaHCO_3$	9.7x
Sodium sulphate	Na_2SO_4	3.5x
Sodium chloride	NaCl	2.6x

xRun considered completed when sodium in the effluent exceeded 5 ppm as $CaCO_3$.

Characteristics of Effluent with Mixed Salts

Following the same test procedure, Fig. 4 shows results obtained when there is a mixture of salts present in the water rather than a single salt. The total cation content of the mixture was equivalent to 10 grains per gallon of calcium carbonate and the proportion of calcium and sodium ions was varied.

Figure 5 indicates that the substitution of sulphate for chloride and of magnesium for calcium produced results identical to those illustrated in Fig. 4 for a water containing the same equivalent per cent of sodium ion.

Figure 6 correlates the data of Figs. 4 and 5 and shows that in the case of raw water containing no bicarbonate the sodium ion affects the average acidity and the critical point to a marked degree.

With water samples containing bicarbonate, both the character of the effluent and the exchange capacity are dependent on the percentage of sodium ion present. The data is presented graphically in Figs. 7 and 8.

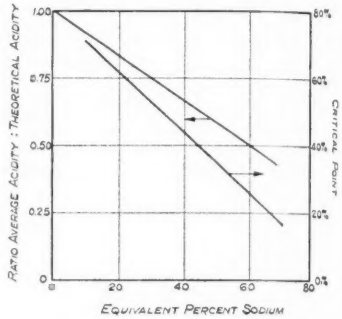


Fig. 7. Variation of acidity ratios and critical points with equivalent percent sodium

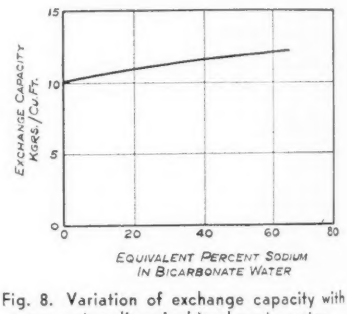


Fig. 8. Variation of exchange capacity with percent sodium in bicarbonate water

The explanation of the effect of the sodium ion on the effluent is that the Na_2Z formed by the reaction of sodium salts in the raw water with the H_2Z bed has the ability in itself to remove calcium and magnesium (Reaction d). After an equilibrium has been reached in the bed between the cations in the raw water and the Na_2Z and H_2Z in the bed, the sodium ion in the raw water will pass through the bed without reaction and the effluent acidity will remain constant for the remainder of the softening period.

In view of the greater exchange with water containing bicarbonate, as shown by Table I, tests were

Table II. Comparison of results

Test No.	Ratio of Average Mineral Acidity to Theoretical Mineral Acidity		Hyd. Exchange Cap.		Critical Point	
	Predicted	*Determined*	*Predicted*	*Determined*	*Predicted*	*Determined*
1	0.65	0.61	10.2	9.9	40	43
2	0.58*	0.59	8.3	8.0	22	19
3	0.58*	0.49	9.3	9.3	27	24
4	0.88	0.83	8.3	8.7	42	31

*These samples contained no sulphates.

run to determine the effect on the exchange capacity of varying the proportion of bicarbonate ion. The water samples used contained only calcium chloride and calcium bicarbonate. The results are given graphically in Fig. 9.

It is quite clear from the above that it would be erroneous to use the ratio of 0.88 of actual mineral acidity to theoretical mineral acidity for all water supplies, even though this figure might be satisfactory as an average. Also, this

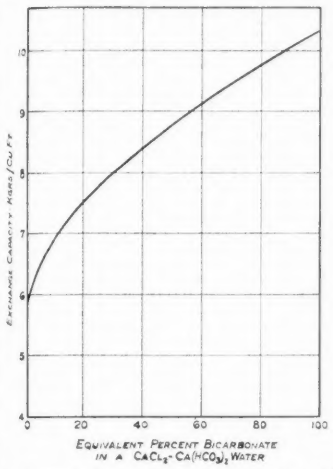


Fig. 9. Variation of exchange capacity with calcium bicarbonate and calcium chloride in water

average figure need not be used when we have available the data presented in Figs. 3 to 10, inclusive.

With the data already given and from additional tests made on synthetic waters containing various combinations of cations (calcium, magnesium and sodium), and anions (chlorides, sulphates and nitrates), Graphs I, II and III, Fig. 10, have been prepared for use in predicting the results that may be expected when softening water by a carbonaceous type zeolite mineral regenerated with sulphuric acid.

To determine the average acidity of the effluent water of a hydrogen zeolite softener when the raw water analysis is known, the following steps are taken:

(1) From the raw water analysis, determine the equivalent per cent sodium and the equivalent per cent bicarbonate ion in the water.

(2) From Graph I determine the ratio of the average mineral acidity to the theoretical mineral acidity by reading along the abscissa the equivalent per cent sodium following up to the first straight line, interpolating for the equivalent per cent bicarbonate and following over to the ordinate for the correct ratio.

(3) From Graph II determine the hydrogen exchange capacity by steps similar to those explained in the preceding paragraph.

(4) From Graph III determine the per cent of the total run at which the acidity begins to drop.

(5) To determine the number of gallons which will be softened by one cubic foot of hydrogen zeolite regenerated with 2 lb of sulphuric acid, multiply the theoretical mineral acidity in equivalents per million by the ratio of the average mineral acidity to the theoretical mineral acidity. To the product, add the HCO_3 present in the water in equivalents per million and convert the sum to grains per gallon $CaCO_3$. Divide the exchange capacity as determined in step 3 by the grains per gallon $CaCO_3$ just calculated to arrive at the gallons softened by one cubic foot.

Illustration

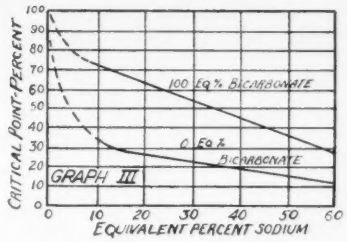
The following is an analysis of a synthetic water made up of Philadelphia city water plus added salts:

Analysis of synthetic water

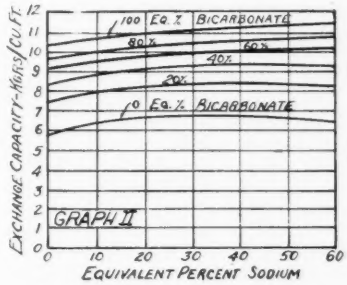
$CaCO_3$	112 ppm	Ca	2.26 equiva./million
$CaSO_4$	2 ppm	Mg	0.02
$MgCO_3$	1 ppm	Na	1.20
SiO_2	5 ppm	HCO_3	2.25
R_2O_3	2 ppm	SO_4	1.01
Na_2SO_4	70 ppm	Cl	0.22
NaCl	13 ppm	Equivalent per cent sodium = 34.5%	
V & O	3 ppm	Equivalent per cent bicarbonate = 64.6%	
T.S.	208 ppm		

1. Equivalent % Na = 34.5%; equivalent % HCO_3 = 64.6%
2. Ratio average mineral acidity; theoretical mineral acidity = 0.65
3. Hydrogen exchange capacity = 10.2 kg $CaCO_3/ft^3$
4. At 40% of the total run, the acidity will begin to drop
5. Theoretical mineral acidity; SO_4 1.01, Cl 0.22, = 1.23

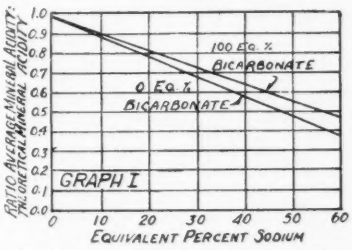
1.23 × 0.65 = 0.80 equivalents per million average min acidity
2.25 equivalents per million HCO_3 to form H_2CO_3
3.05 equivalents per million average acidity
3.05 × 50 = 152.5 ppm $CaCO_3$ = 8.9 gr/gal $CaCO_3$ average total acidity
8700 grains $CaCO_3$/cu ft ÷ 8.9 = 1090 gallons softener/ft^3 H_2Z



Prediction of Critical Point



Prediction of Exchange Capacity


RATIO AVERAGE MINERAL ACIDITY: THEORETICAL MINERAL ACIDITY
100 EQ. % BICARBONATE
0 EQ % BICARBONATE
GRAPH I
EQUIVALENT PERCENT SODIUM

Prediction of Average Mineral Acidity

Fig. 10. Graphs prepared for predicting results expected when softening water by a carbonaceous type zeolite mineral regenerated with sulphuric acid

The reliability of the data is shown in Table II in which predictions as to the character of the effluent, based upon analysis of the raw water, are compared with the actual effluent as determined by tests.

Conclusions

It is no longer necessary to depend upon an average coefficient of exchange in predicting the performance of an acid regenerated carbonaceous zeolite exchange unit, but the characteristics of the effluent can be predicted precisely from an accurate analysis of the raw water and knowledge of the quality of the carbonaceous zeolite. In the present investigation two varieties of carbonaceous zeolite were tested, with identical results, and it is quite likely that the same characteristics will be found in other varieties. With such data, the equipment can be designed intelligently and with accuracy.

Restoring a Corroded Penstock

If upkeep and maintenance were ever of importance, they are especially so at the present time when new material is difficult or impossible to obtain. This article describes the treatment of a badly corroded steel penstock, 500 ft long and 10 ft in diameter. Oxy-acetylene flame-priming was used to remove rust and scale before applying a protective paint. This left the surface clean and dry

OXY-ACETYLENE flame-priming recently solved a number of problems connected with the preparation of the interior of a badly corroded penstock for protective painting. Flame-priming employs the intense quick heat of oxy-acetylene flames to expand rust and loose scale, causing it to pop off the relatively unaffected metal beneath, and to drive out the surface moisture. The treatment leaves the surface clean, dry, and warm, making paint go on faster, bond tighter, and last longer. In addition it has the effect of giving the paint that is applied a low temperature bake, which increases its resistance to corrosion and prolongs its life considerably.

The underground penstock—exceedingly difficult to replace with new material at the present time—was made of steel pipe 10 ft in diameter and 550 ft long, and had been in service a number of years, conveying water from a dam to the mill for the generation of power. Its walls had once been protected from corrosion by a coating of protective material, but this had almost completely disappeared, and it was imperative that a new protective coat be applied at once—or soon there would be no penstock.

A satisfactory new coat could not be applied, however, until the surface had been cleaned and dehydrated, an operation that called for speed as well as thoroughness, since the mill would be without power for its duration.

When the penstock had been drained, inspection of the walls revealed much rust and scale and the presence of large scabs or cauliflower-like growths resulting from pitting and the building-up of rust deposits. Beneath these scabs were large pits that would have to be cleaned out to sound metal. Of equal importance was the necessity of removing moisture that existed on the pipe walls in order to assure a satisfactory bond and a lasting paint job.

Note: All photographs in this article supplied by courtesy of the Linde Air Products Co.

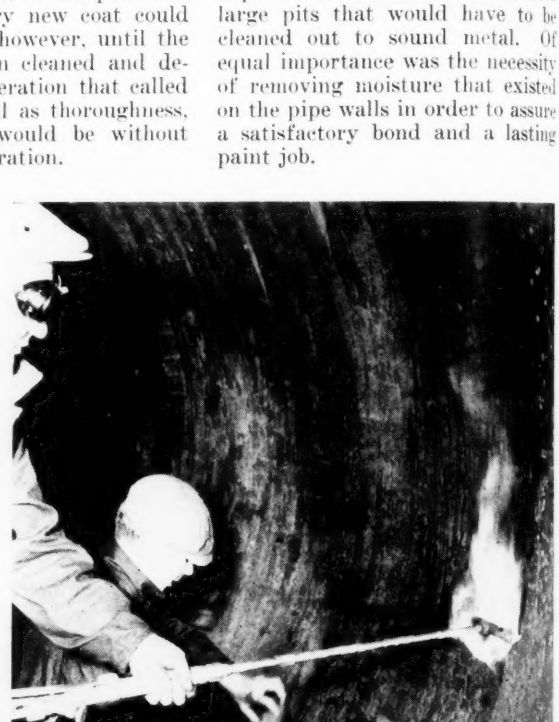
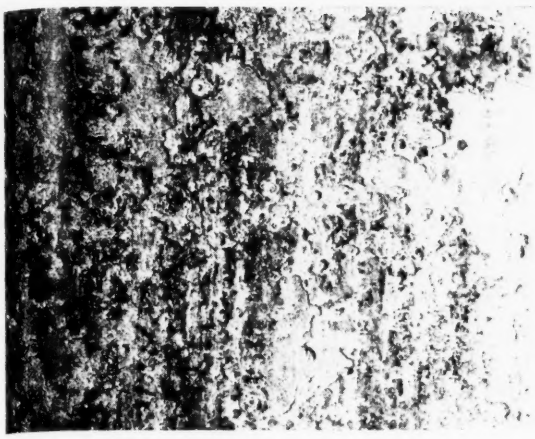


Fig. 1. (Above) The flame-priming blowpipe provided a series of high-velocity, high temperature oxy-acetylene flames that rapidly heated the surface, popping off loose scale and breaking down rust to a granular powder. A helper followed with a wire brush to remove the freed rust and scale

Fig. 2. (Left) This view of the penstock, which is 550 ft in length, shows part of the large surface area being prepared for a protective coat by flame-priming



Figs. 3 and 4. These two photographs show the appearance of the badly corroded interior wall of the penstock; left, before flame-priming and right, after flame-priming, with the pits cleaned out to sound metal

The first attempt to remove rust and remove scale by scraping and chipping proved unsatisfactory. Although eight men were employed, the work was slow and tedious and much handicapped by the excessive moisture which made the rust areas muddy, spongy, and impossible to remove completely. Another problem was to clean thoroughly the irregular areas around the rivet heads.

Only Three Men Needed to Do the Work

On learning of the adaptability and speed of flame-priming, the company decided to employ this process for the work. Pipe walls were swept down to remove the thick mud, loose material, and dirt, and a crew of only three men then undertook to flame-prime the entire surface area of the penstock and to paint it. Ventilation was provided by a ventilator installed in an above-ground manhole, which kept a gentle current of air moving through the penstock.

The flame-priming operator employed a regular heavy-duty welding blowpipe with an extension arm and a flame-priming head, which has a number of closely spaced flame ports providing a series of high-velocity, high-temperature flames. This heating head was held close to the surface, by means of a long extension arm, so that its high-velocity flames could exert their "blasting" effect even in the deep pits. Due to its design, the same head could be used with complete success to clean the surface surrounding rivets. Hard-faced skids on either end of the head kept it the correct distance from the work and protected it from abrasive wear.

Continuous Operation

Oxygen and acetylene cylinders were moved into location on a portable welding truck. During the work, the flame-priming operator was immediately followed by a helper who swept off the granulated, dehydrated rust. Following him, the painter applied the protective coat to the clean, dry surface that was still warm and ideally conditioned to receive it. All three men worked within a few feet of each other in one continuous operation. The entire penstock was flame-primed and painted in this manner at a great saving in time and costs. Quality of results at the same time were unusually high, and promised lasting protection.

Method Applicable in Other Cases

The method employed in restoring this corroded penstock can, of course, be used with equal effectiveness in other cases where metal surfaces need attention. The interior of water tanks and oil tanks lend themselves well to this type of treatment. In the case of oil tanks care must be taken to see that all fumes and gases are removed from the containers before applying the blowtorch.

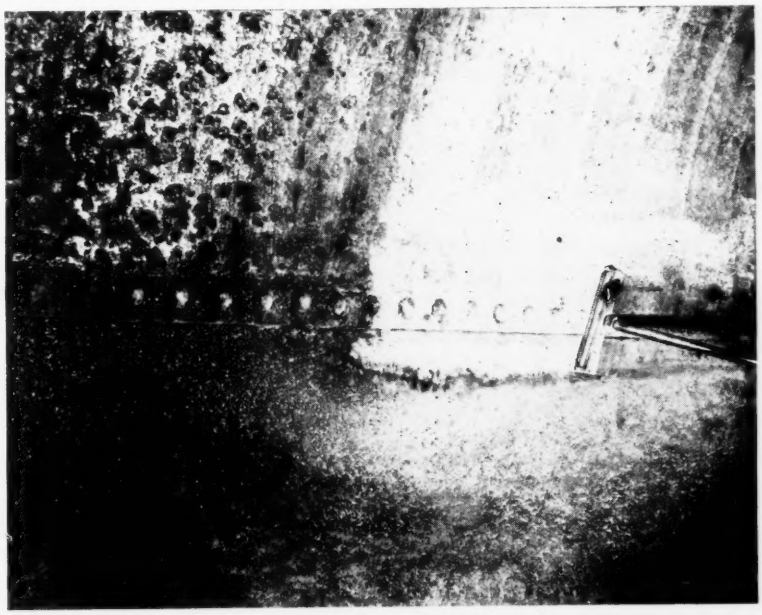


Fig. 5. Areas around rivets, which are hard to reach, were cleaned readily with the flame-priming head. Hard faced skids protect the head from contact with the rivets and keep it the correct distance from the work

ASME Spring Meeting

Emphasis throughout entire program of ASME Spring Meeting was placed on engineering problems connected with production of war materials. Army and Navy officers on program paint picture of progress. Industrial training, manpower, aviation, fuels and power topics were discussed

ENGINEERS engaged in the production of war materials found the Spring Meeting of the American Society of Mechanical Engineers held in Davenport, Iowa, April 26 to 28, one of the most helpful and inspiring the Society has held. Concrete evidence of interest is the fact that the attendance reached about 500 total for the three days. Many of these busy engineers found it necessary to confine their attendance to one or two sessions or only one day of the meeting which caused some variation in the audiences at different sessions but a live interest was maintained throughout.

Outstanding because of their inspirational value were the addresses by Lt. Col. Nathaniel F. Silsbee on the Problems of Global Air War; by H. V. Coes, president of the Society, on What Management Is Contributing to the War Effort; and by Col. James L. Walsh on Engineers Against Time. From these addresses many points were learned about how the strategy of the war is being carried out both in the field and on the home front.

Motion pictures were used in a helpful way to indicate progress in the development of the Sikorsky Helicopter; Otto De Lorenzi used colored movies to describe the burning of fuel in a boiler furnace; and Ralph M. Barnes demonstrated how training of factory employes is aided by motion pictures.

Among other strictly war industry subjects into which engineers have been drawn and which received attention at this meeting were: Desiccation (drying) of human blood plasma, industrial training for war work, war plant maintenance, war contracts, women in war work, management of a loading plant and safety in ordnance establishments. Rounding out the program were sessions devoted to the more peacetime subjects like management, fuel, power, wood industries, aviation, research and production engineering.

"It's unfortunate that more people in government do not recognize the simple fact that one cannot make real progress as long as there is basic conflict between government and business. There should be no real conflict. And as we continue to work side by side in our united efforts to win the war, the shortsightedness of those who would encourage such conflict becomes more and more apparent. The same philosophy is equally applicable, in my opinion, to the relations of labor and management.

"To request that 100,000 military planes be produced in a year does not produce them, as we well know; this is just a request for production. These demands set in motion, however, such gigantic engineering projects as the Chrysler Corporation's new plane engine factory in Chicago, one of the largest plants in the world. This, in itself, is an engineering feat which, in many respects, rivals our Boulder Dam hydroelectric project."—Harold V. Coes.

Power Plant Operation in Wartime

Carrying greatly increased loads with existing equipment is the important problem to be met in operating power plants under wartime conditions, was the opinion expressed by G. H. Suhs, chief engineer of the Sorg Paper Co. The major problems are met in the boiler room and more particularly in the boilers and furnaces. Fuel troubles are certain to develop with increased ratings. Power house efficiencies may be sacrificed to production progress. The operating engineer must work out his own problems, he must keep going with the immediately available supplies and materials.

Experiences in his own plant were cited which led Mr. Suhs to the above conclusions. For example, increased boiler capacity was demanded. To meet this a shift to more easily ground coal was necessary, the price of this coal was 30 to 50 cents more per ton. Pulverizing equipment was revised to increase capacity by 15 per cent. Burners were revised. Higher ratings increased furnace temperatures with resultant refractory and slag trouble. Refractory faced water wall blocks were replaced with bare blocks. The exhauster fan on the pulverizers was turbine driven and gave unsatisfactory regulation, so this was changed to constant speed motor drive with damper control in the feed line. High gas temperatures burned out soot blower elements. The last resort was to reduce the superheated steam temperature from 750 to 675 F by changing baffle arrangement. Such examples go to show that equipment as designed has definite limits which, if exceeded, result in

(*Continued on page* 122)

Papers Dealing with Power Topics

Operation of Industrial Power Plants under Wartime Conditions. G. H. Suhs, Sorg Paper Co.

Colored Movies on Fuel Burning Operation and Maintenance During Wartime. Shown by Otto de Lorenzi, Combustion Engineering Co.

Plant Perpetuation. J. C. Hobbs, U. S. Navy.

Caustic Washing of Turbine Blades Under Load. W. L. Webb and R. G. Call, American Gas & Electric Co.

Chemical Removal of Scale from Heat Exchange Equipment. F. N. Alquist and C. H. Groom, Dow Chemical Co., and Guy F. Williams, Dowell, Inc.

Lignite-Influence of Storage Conditions Upon Size Degradation, Size Stability, and Friability. Carl J. Eckhardt, Jr. and C. W. Yates, University of Texas.

Iowa Coals in the National Emergency. H. L. Olin, Univ. of Iowa.

Performance Characteristics of a Down-Draft Coking Furnace. J. R. Fellows, Univ. of Illinois.

Steam-Air Jets for Producing Furnace Turbulence. R. B. Engdahl, Battelle Memorial Institute.

Direct-Fired High-Temperature Carbon-Steel Air Heaters. R. M. Rush, Dravo Corp.

Theory of the Expanding of Boiler and Condenser Tube Joints Through Rolling. A. Nadai, Westinghouse Research Laboratories.

Creep of Metals at Elevated Temperatures. The Hyperbolic Line Relation Between Stress and Creep Rate. P. G. McVetty, Westinghouse Research Laboratories.

Heat Transfer and Pressure Drop in Annuli. Elmer S. Davis, American Locomotive Co.

Heat Transfer to a Fluid Flowing Periodically at Low Frequencies in a Vertical Tube. R. C. Martinelli, L. M. K. Boelter and S. Yakahi, Univ. of California and E. B. Weinberg, Modesto Junior College.

Rate of Ice Formation. A. L. London and R. A. Seban, Stanford Univ.

Performance and Selection of Mechanical-Draft Cooling Towers. Joseph Lichtenstein, Foster Wheeler Corp.

The PRACTICAL ENGINEER and ELECTRICIAN

ANDREW W. KRAMER, EDITOR

C'EST LA GUERRE!

I get very much "fed up" with people who continually fret and grumble about the difficulty of getting along these days, how difficult it is to do business or to keep a plant in operation. If a machine breaks down and they can not immediately get a new part for it they launch into a tirade against the nitwits in Washington. There are no doubt quite a number of nitwits in Washington, there are among any considerable group of people and Washington is only a representative cross-section of the population of the United States. Of course, it is difficult to get parts or new material these days but if you can prove that you really need them in support of the war effort, you can get them, provided they are available. If they are not available it is only because they are probably more urgently needed elsewhere. The trouble with most of these people who grumble is not, as some declare, that they do not realize that we are at war but rather that they do not realize what a very tough war it is. If anybody in this country feels they are having a hard time of it, let them read Boris Voyetekhov's account of "The last days of Sevastopol" in recent issues of the Saturday Evening Post. If this eye-witness account of one of history's greatest demonstrations of mass courage and resolute self-sacrificing patriotism fails to make them ashamed of their grumblings about their petty problems and imagined hardships, well, then there is something very wrong with them. Suppose you cannot get the equipment you need! Have you ever thought of making it? See page 93 and see what Bill Otto did when he needed a new coal conveyor for use in his boiler room. He thinks more of that home made machine than he ever did of a brand new super dooper unit he purchased from a factory.

A.W.K.

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Maintenance of Electrical Contactors

Despite the fact that contactors often operate without attention in more or less out of the way places, they are very important devices. They need a certain amount of attention. In this article the author discusses the character of different types of trouble which may arise in the operation of contactors and describes in considerable detail the steps necessary to detect and correct these troubles

By W. W. McCULLOUGH
Service Department, Westinghouse Electric & Mfg. Co.

Motors are familiar pieces of rotating apparatus. They get pretty fair maintenance because they rotate. Not so much attention is paid to contactors, yet this at a time as a consequence of the fantastic increase in welding they really occupy a key position. Speaking conservatively, there are several million contactors in daily use in the United States. Actual figures on the maintenance of contactors are hard to get because it is seldom that any accurate record is kept.

Maintenance is very simple in plants using contactors that operate infrequently. At the other extreme are contactors which are used on heavy production work such as welding, applications where the maintenance is so high that contactors must be replaced, either piecemeal or all at once, if possible twice a year.

Contactors are applied in control as well as power circuits, singly and in groups, with load currents on the main contacts ranging from fractions of an ampere to thousands of amperes, but whatever the application, the maintenance in general is the same with the exception of frequency of attention.

Inspection

The first requirement in the satisfactory maintenance of electrical apparatus is competent inspection. This is probably as good an introduction as can be found for any subject dealing with maintenance. For intelligent maintenance follow carefully the manufacturer's instruction leaflets or instruction books applying to the particular piece of apparatus.

Obviously no general rule can be given for frequency of inspection. Some contactors have to be inspected every day. A regular schedule should be arranged so that all contactors in actual service are gone over at least once a month. Add to this as equally important, an adequate stock of renewal parts.

Direct-Current Contactors

These contactors are furnished with or without magnetic blow out coils, depending on the circuit application. In general, all wearing parts are made of steel or bronze and all metallic parts are treated in some manner in order to prevent corrosion. Arc shields are made of moulded heat resisting compounds and are so arranged that they can be removed or rotated out of the way in order to inspect the main contacts. Some contactors are equipped (here again the application is the determining factor) with arc splitters for quickly cooling, lengthening and rupturing the arc. The main contacts are usually made of copper (some special applications use silver or other materials as dictated by the application) and close with a rolling movement combined with a wiping action which insures good contact and confines the arcing with resultant burning to the tips of the contacts. Modern copper contacts are often silver plated not because silver doesn't oxidize in the atmosphere but to take advantage of the fact that silver oxide is a good conductor, while copper oxide is a very poor one. Conventional contactors are spring loaded to insure positive contact pressure and to accelerate the opening of the contacts.

Maintenance

The use of a lubricant on the contacts or bearings of a contactor is to be avoided. Oil quickly collects dust and unless parts are cleaned frequently, will interfere with the operation of the contactor. Oily surfaces that collect dust may also result in an arc between live parts of the contactor.

Flexible braided copper shunts are designed to give complete freedom to the moving armature with sufficient current carrying capacity. Burned or badly corroded shunts should be replaced promptly. When making regular inspections check clearance between shunts and points of opposite polarity for ground so as to forestall possible arc-overs.

The contacts normally wear to give the best contact surface without any attention. The roughened appearance of the contacts is no indication that good contact is not being obtained, but of course any little globules of copper that prevent the contacts from seating should be dressed off. When the contact surfaces are burned to such an extent that the current carrying surfaces are materially affected, they should be replaced.

Auxiliary contacts, if there are any, should be checked to insure that they have the correct travel and correct pres-

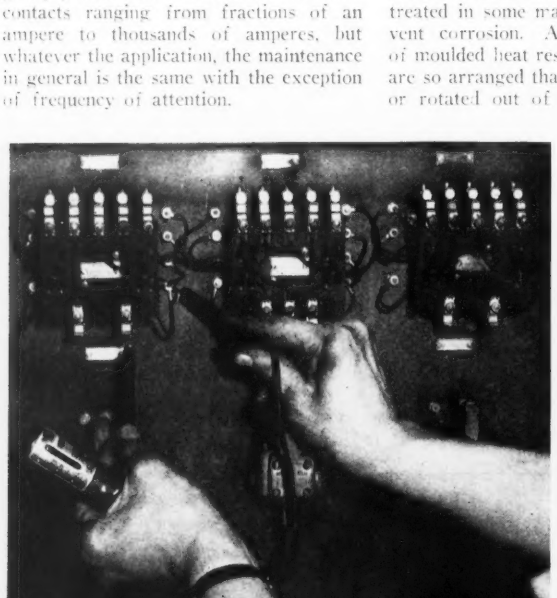


Fig. 1. Checking contactor voltage is a very simple matter using the magnetic type indicator shown in the left hand

Fig. 2. Arc chutes are adjusted periodically to preserve contactor life

sure. Keep the contact surfaces clean and see that all connections to the auxiliary contacts are clean and tight.

Check Contact Pressure To Avoid Excessive Heating

Contact pressures can be checked to insure they are as specified by the manufacturer, by the use of a spring balance as follows. Insert a piece of tissue paper between the mechanically tightly closed contacts. Fasten one end of the spring balance to the mounting screw of the moving contact tip and read in pounds the pull required to loosen the paper between the contact tips. In case the contact pressure is below the minimum value required, install a new spring. Low spring pressure should be guarded against to avoid excessive heating of the contacts. Excessive heating increases the resistance which may cause sufficient arcing to weld the contacts together.

Range of Contact Pressure To Be Maintained On Typical Widely Used Contactors

Type of Contactor	No. Poles	C. P.
30-C	1	3- 4
40-C	1	6- 7½
50-C	1	12-14
62-C	2	18-22
72-C3	2	32-36
82-C3	2	47-52
101-SM	1	6- 8
102-SM	1	9-12
104-SM	1	20-25
108-SM	1	20-25
35-F	2	3- 3½
45-F	2	6- 7½
55-F	2	12-14
62-F	2	18-22
35-F	3	3- 3½
45-F	3	6- 7½
55-F	3	12-14
37-F	5	3- 3½
47-F	5	6- 7½
57-F	5	12-14
67-F	5	24-26

*Contact Pressure at heel of contact tip measured in pounds.

There is probably no general rule applicable to contact pressure of a contactor. The manufacturer's recommendations should be followed. The accompanying table shows the range of contact pressure which should be maintained on various a-c and d-c contactors widely used. This information will give a general idea for other contactors of similar types.

Check Contact Gap To Keep Original Pickup

The contact gap should be maintained in accordance with the manufacturer's instruction. The gap is measured at the heel of the contact with the contactor in the full open position. Too great a gap may prevent the contactor from picking up or closing on the minimum voltage for which the operating coil is designed. It is important to check this gap on contactors which have been in severe service long enough to require frequent rebuilding. This applies especially to contactors in welding circuits because the closing time of the contactor depends on the gap.

Arc Shields Important

Arc shields should always be down so that the arc is broken within the field of the blow out coil, otherwise the shield will not give satisfactory results.

Arc shields should be renewed before the moulded material is burned away sufficiently to expose any metal parts to the arc.

Check Alignment of Magnetic Circuit

The sealing surfaces of the magnet core and armature should be kept clean to insure proper contact. The moving armature on its hinge pin is so arranged in most designs that it is self-aligning. Excessive wear or damage to the mechanism may make it necessary to replace worn or damaged parts to obtain proper alignment. Often removal of high spots on the contact surfaces of the moving and stationary armatures by filing, will remedy improper alignment.

Watch Operating Coils

Operating coils are designed to operate the contactor successfully with a voltage that varies from 80 per cent to 110 per cent of the normal rated voltage of the coil. All connections to the coil should be kept clean and tight.

Trouble Shooting

Failure to close may be due to one of the following:

1. Operating coil may be open circuited.
2. Lead wires to operating coil may be loose or disconnected.
3. Excessive mechanical friction.
4. Power off or voltage below normal.

Failure to open may be due to:

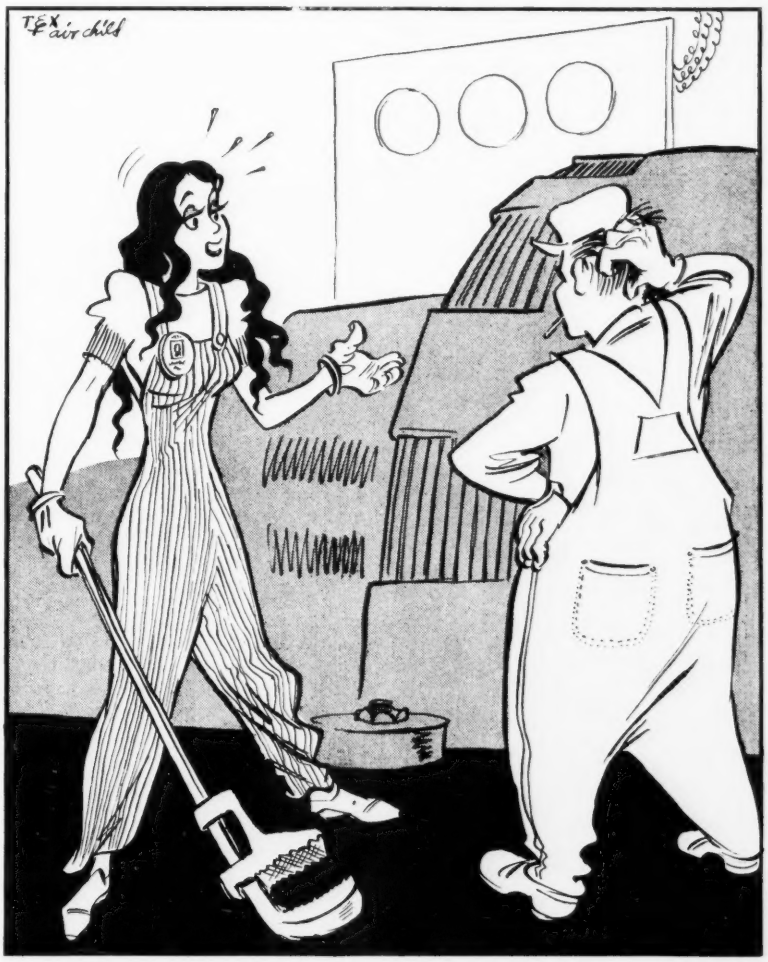
1. Mechanical interference or friction.
2. Welded contacts.
3. Broken contact spring.

Alternating-Current Contactors

Alternating current contactors are very much like direct current contactors which have just been discussed. Older designs used similar magnetic blow-out systems. Many modern design a-c contactors are different because they have de-ion arc quenchers. De-ion arc quenching action confines, divides and extinguishes the arc almost instantaneously as the circuit is broken.

The de-ion arc quencher is more than just a designer's neat scheme to assure safe operation and give greater efficiency from a contactor. The invention is revolutionary from the standpoint of maintenance. Pitting and burning of contacts and arc box are greatly reduced and longer trouble-free life provided than ever before considered possible.

De-ion action not only stretches the arc, as by old method, but confines and quenches it. As the specially shaped con-



"Oh, I fixed it alright, but with hairpins so hard to get, I don't know how I'm going to keep my hair up"

Fig. 3. Sanding sliding contacts on elevator controls

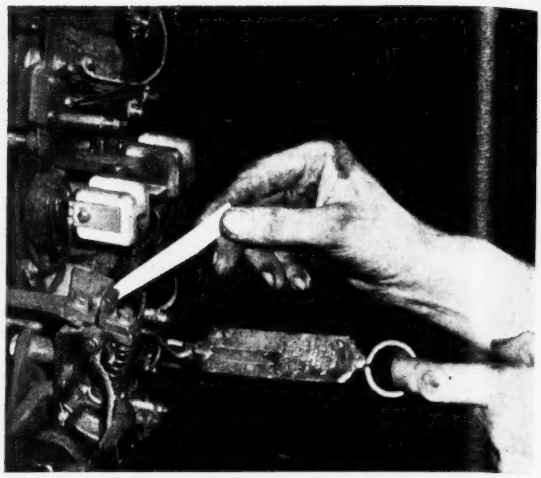


Fig. 4. A small spring balance is used to measure contact pressure

tacts separate, a magnetic reaction occurs that forces the two stretching arcs to join across the stationary contacts. Here it rises immediately into the de-ion grids where it is "sliced" into a series of arcs. At the next zero point on the current cycle, the air adjacent to each grid is de-ionized instantly, the voltage per grid is insufficient to re-establish the current and the arc is "out".

Safety is thus assured and higher overload capacity made possible. Pitting and burning of contacts and arc box is greatly reduced and longer, trouble-free life provided than ever before considered possible.

The arc quencher is assembled over the contacts in much the same manner as the magnetic blow out coils and arc shields on the conventional contactor and is easily removed for inspection of the contacts.

Another difference is that a shading coil is used in the face of the stationary core of an a-c contactor to reduce the magnetic hum. This shading coil plays a very important part and must be checked periodically. It operates at a temperature high enough to cause excessive oxidation of the metal (usually brass).

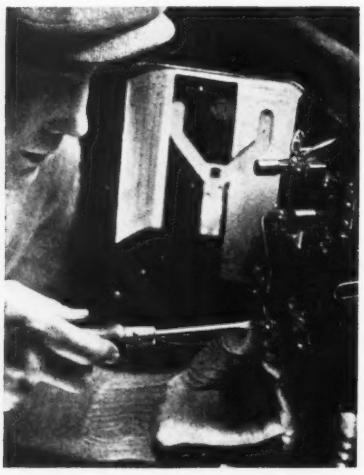


Fig. 5. Ease of installation and accessibility of terminals and all parts are important features of modern contactors. This is a 25 amp a-c across-the-line starter

Why Is A Shading Coil Used?

In a single-phase, alternating current magnet without some modifying feature the pull is proportional at all times to the instantaneous value of the exciting current and reaches zero twice every cycle. The result is that the magnet starts to open every time the pull reaches zero. The mass of the moving part is usually large enough to prevent complete opening during this small interval of time, but there is enough movement to cause severe chattering and noise.

In a polyphase magnet the pull is continuous since the voltages impressed upon separate phases overlap each other.

To produce a relatively quiet single-phase magnet then, the problem is to obtain the equivalent of polyphase conditions. This is accomplished by the use of a shading coil or short-circuited winding placed around part of the pole face. The current induced in this shading coil produces a flux in that part of the magnet circuit surrounded by the shading coil which is out of phase with the main flux. The combination of these two fluxes produces a pull which never reaches zero.

Inspection and Maintenance

The information just given for maintenance of d-c contactors applies to a-c contactors as well. However, due to the possible noisy magnetic hum in the magnet it is imperative that the surfaces of the moving and stationary armatures be in the best possible alignment.

Correcting Noise

If the humming should become excessive, check the following: (1) The sealing surfaces of the magnet may be corroded, thus keeping the magnet from sealing perfectly. (2) The mechanical parts of the magnetic surface may be so distorted that the moving armature cannot find a square seat. Check this by closing the contactor electrically after placing a sheet of tissue paper between the surfaces. (3) The voltage may be low. (4) The shading coil may be broken. (5) Spring pressure may be high.

Operating Coils

Operating coils are critical to imperfect alignment of the magnet circuit. If recurrent failure of operating coils has been experienced and the operating voltage is within the manufacturer's operating limits, look for mechanical faults in the magnetic circuit. The watts input to the coil required for "hold-in" is fixed for a given closed position of the contactor. A slight gap in the magnet may increase the current in the operating coil dangerously by lowering the power factor.

Oil Immersed Contactors

The tanks of oil immersed contactors should be kept filled to the proper level. Use approved transformer oil and see that it is kept dry and clean.

In general, oil immersed contactors should have the same attention as oil circuit breakers of comparable voltage.

Remember that all circuits must be dead before the tank is lowered for inspection.

Operating Temperatures of Electrical Equipment

Due to the inherent characteristics of insulating materials in general, high temperatures shorten the life of electrical apparatus. The total (or actual) temperature, not the temperature rise, should be the measure of safe operation—a relatively low temperature rise with a very high ambient may result in rapid deterioration of the insulation. When either the windings or the bearings of a machine not specially designed for high temperature service attain temperatures in excess of 90 C, the operating conditions should be investigated. The cause of gradually rising temperatures during a considerable period of time should be found and abnormal conditions should be corrected. Sharply rising temperatures generally warrant a shut-down and a thorough examination of the apparatus.

(From Westinghouse "Maintenance Hints")

PRACTICAL HINTS AND KINKS

Extending Coal Handling Facilities in Wartime

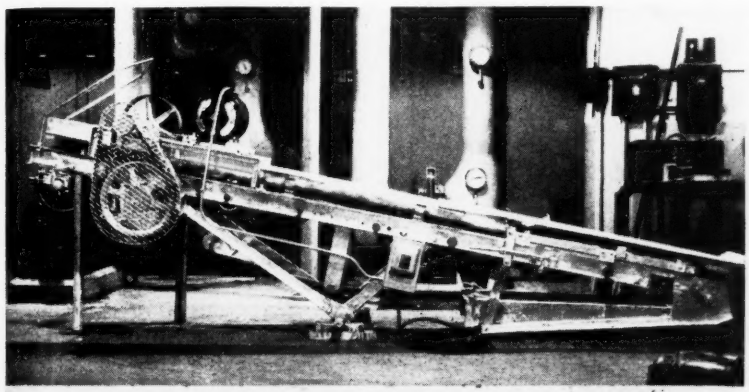
By William Otto

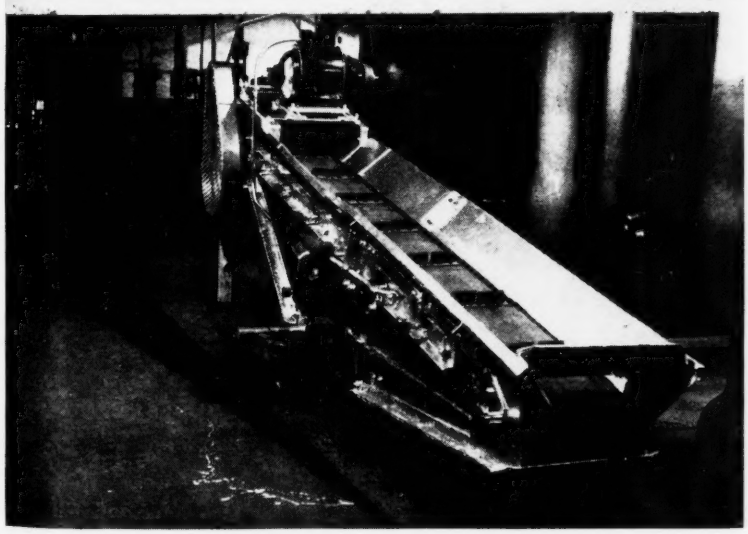
THE SCARCITY of material and the freezing of certain types of equipment against civilian use had made repair work in the average power plant quite a problem. In our plant, which serves a large Chicago department store, we try to pick up miscellaneous parts available at the junk yards and when that fails, we make the parts ourselves.

As an example of how we operate, recently we purchased a second hand coal loader which was needed to feed coal to the hoppers supplying the stokers. This loader operates from a monorail to permit moving it from one boiler to another. When we received the loader we could not use it because of its bad condition—the rollers were badly worn, majority of the teeth on the gears and pinions were missing, and the motor was beyond repair—so we went to work on it.

We secured some old 3 in. pipe and cut it to the right lengths, welded ends on the rollers, drilled 5/8 in. holes for 3/8 in. pipe (which we used for shafts), picked up some old shaft hangers with bearings, welded ears on the bearings and used them for pillow blocks, and babbitted the bearings for 3/8 in. pipe. We searched the plant for old pulleys and grooved them for a rope drive, and found a motor of a higher speed, which necessitated the installation of a jackshaft to bring the speed down to 25 rpm.

The conveyor works perfectly. Views of it are shown in the accompanying photograph.



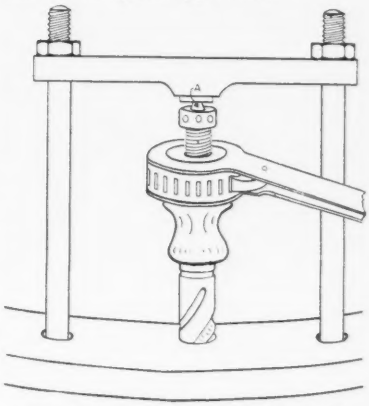


Two views of the repaired coal conveyor

Gear Puller as an Old Man

By GEORGE HOLMAN

SOME YEARS ago I had to install a new cylinder on a steam engine. On taking off the old cylinder I discovered that the holes, tapped for 1.5 in. studs, while of the correct pitch for the machine frame, were located one-half pitch from the proper position necessary to line up the piston type valve.



No drill press was available with a head high enough to take the cylinder when standing on end. Since the only alternative to a return of the cylinder to the factory was to drill the holes and tap them by hand, I made the set-up shown in the sketch, using an old ratchet drill. The Old Man was a gear puller, with the centering screw replaced by a lathe-centered stud A.

Return Your Gas Cylinders Promptly

THE SHORTAGE of cylinders for chlorine, ammonia, carbon dioxide, and other compressed gases needed by many essential industries is becoming more and more acute, and, to prevent drastic restrictions in the distribution of these chemicals, all users and transportation companies must cooperate in returning the containers to the producers, warns R. J. Quinn of the Mathieson Alkali Works, Inc.

"Most users of compressed gases are probably trying to return their cylinders promptly, but many find that the railroads and the trucking companies are becoming increasingly unwilling to handle small shipments," states Mr. Quinn. "This situation can be remedied, however, if transportation managers fully understand the importance of getting cylinders back for refilling as quickly as possible, and if shippers of cylinders will cooperate with the transport companies in arranging shipments that can be handled economically.

"No new cylinders can be obtained, and the number being diverted from civilian use by our war effort is constantly increasing," Mr. Quinn points out. "But if all concerned will keep the available supply in constant circulation, it should be possible to serve satisfactorily all important users of compressed gases.

"To everyone who is helping in this vital task, we want to say 'Thanks for the Tanks!'"

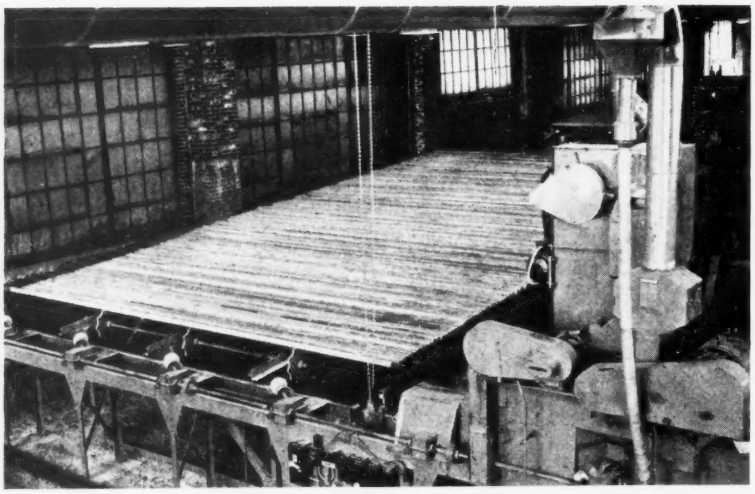


Fig. 1. The lower end of the dirty flue rack, showing the Wheelabrator blast cleaning machine in the foreground

Flue Cleaning Deluxe

One of the bugbears of the boiler operator's life is flue cleaning. At best it is a messy job, not at all inspiring and to do it properly takes skill and understanding. It is an important job as anybody who has read Atomizer John's articles on the subject in this section can appreciate. Here is another article on the subject, but this concerns a different type of flue cleaning than that to which the stationary boiler plant operator is accustomed. This discussion concerns not stationary boiler tubes but railroad locomotive boiler tubes. It describes what might be called "mass production" flue cleaning, because it makes use of the same type of streamlined mass production methods used in modern industry. This method, developed in the shops of the Erie Railroad Co., utilizing conveyors, photocells, welding machines and heat treatment is as near automatic as it can feasibly be made. The method may not be applicable to stationary boiler practice, but certain features might be incorporated in stationary practice. The welding on of new ends, for example, could be adopted to good advantage in many plants. Aside from any practical value the system might have for stationary boiler plant operators, the article is of general engineering interest and we are glad to have the opportunity of presenting it in these pages

THE ERIE RAILROAD CO., at its Hornell (New York) shops, has adopted straight-line production methods with outstanding success in its boiler flue cleaning department. Boiler tubes are moved from one repair operation to the next by means of gravity racks and power driven conveyors, minimizing handling and speeding tube reconditioning.

Boiler flues, while subject of careful attention every time a locomotive goes into the shops for heavy repairs, are removed from the boiler for thorough cleaning and inspection at least once every 5 yr. Calcium and magnesium salts from the boiler water are deposited upon the flues, providing undesirable scale. Under some boiler water conditions flues corrode, resulting in pitting and weakening of the tube wall which makes occasional flue removal for thorough cleaning and inspection necessary.

The boiler flue entering the Erie flue cleaning shop may range from 2 to 5½ in. in diameter, and from 11½ to 24 ft. long. It has two ragged ends that result from cutting from the boiler flue sheets, and is therefore short of the length necessary for re-use in the same boiler.

Steps Involved in the Process

Nine operations enter into Erie's flue reconditioning program at Hornell:

1. One ragged end, that removed from the firebox flue sheet when the tube was in the boiler, is cut off.

2. Scale is cleaned from the outside of the flue as it passes through an airless blast cleaning machine.

3. Flue is inspected for pits or other flaws.

4. A short piece of new tubing is welded to the end cut off in the first operation.

5. This end, termed the "safe end," is brought to forging heat in an oil furnace.

6. The heated end is swaged to fit the firebox flue sheet hole.

7. A section is cut off the opposite end, eliminating the other ragged end and at the same time bringing the flue to proper length.

8. The end just cut is annealed by heating to 1600 deg. F. in an oil furnace. The annealing operation removes any stresses in the metal that may have been set up due to fatigue or by the high-speed saw used for the cutting operation.

9. The end for the front flue sheet hole is formed by a pneumatic clamp die machine, which is employed to size and true the end to fit the front flue sheet hole, and then the tube is let cool in open air.

Uses Separate Building

The flue department is in a building 85 by 148 ft., of brick and steel construction. The structure houses two long gravity conveyor racks, each constructed of three channel and angle iron runways spaced 5 ft. apart. The first rack, which runs parallel to the second is 84 ft. long and it has a slope of 0.7-in. per ft. of length to provide gravity feed for the flues.

Dirty flues are brought to the head of this rack in a track buggy picked up by an overhead crane and set on the dirty flue rack. The first section of the rack is heated by steam coils suspended below it to dry out moisture in the scale. This scale must be reasonably dry for efficient operation of the blast cleaning equipment.

When flues have passed half-way down the dirty flue rack, a cut-off saw removes one end. The saw was designed by Erie engineers, and will make 400 cuts per hr. on any size flue. The saw blade is 42 in. in diameter, and is driven by a 40-hp. motor. A 2-hp. motor drives the feed mechanism to the saw through a reducing gear. In use the operator moves the flue endways about 18 in. while it is resting on ball bearing rollers, placing it for the cut, and then gives it a roll forward. The resultant cut is clean and the end of the flue is not deformed.

Scale Removal

Scale removal is accomplished by a special cabinet model Airless Wheelabrator designed by engineers of American Foundry Equipment Co., Mishawaka, Ind. A blast cleaning method common in cleaning castings and for removing scale from heat-treated metal is employed.

Metallic shot or grit, referred to as abrasive, is thrown by centrifugal force supplied by a rapidly moving wheel against the scale-encrusted flue, stripping off the scale and exposing the clean tube. Much of the scale is reduced to dust as fine as talcum powder, and removed from the cleaner by a suction fan through vertical pipe connections at the top. The dust-laden air passes through an American Dustube dust collector, which drops the dust into a chamber for removal.

Larger particles of scale drop to the bottom of the machine along with the abrasive, and are carried by an elevator to a separator at the top of the cleaner. The separator returns the abrasive to a hopper for re-use, while the scale particles pass into a chamber for disposal.

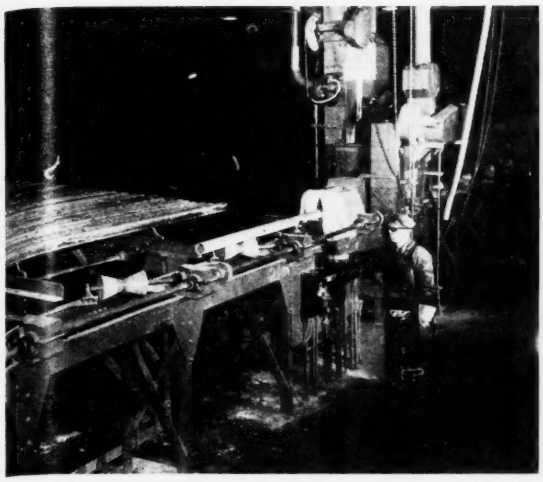


Fig. 2. The charing end of the Wheelabrator blast cleaning machine, showing a tube passing through for cleaning. When the tube clears the dirty flue rack, a photoelectric beam that had been interrupted by the passing flue actuates a set of sprocket wheels that drop the next flue from the rack to the cleaner conveyor

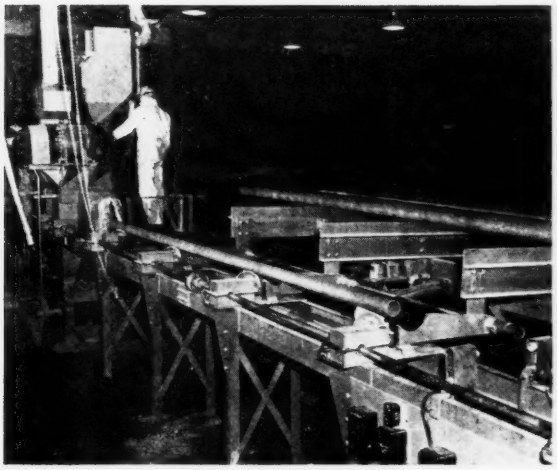


Fig. 3. A cleaned flue is shown emerging from the Wheelabrator blast cleaning machine. When the end of the tube intercepts the beam of the photoelectric cell shown in the lower righthand corner, lifting arms powered by compressed air cylinders transfer the flue to the clean flue rack

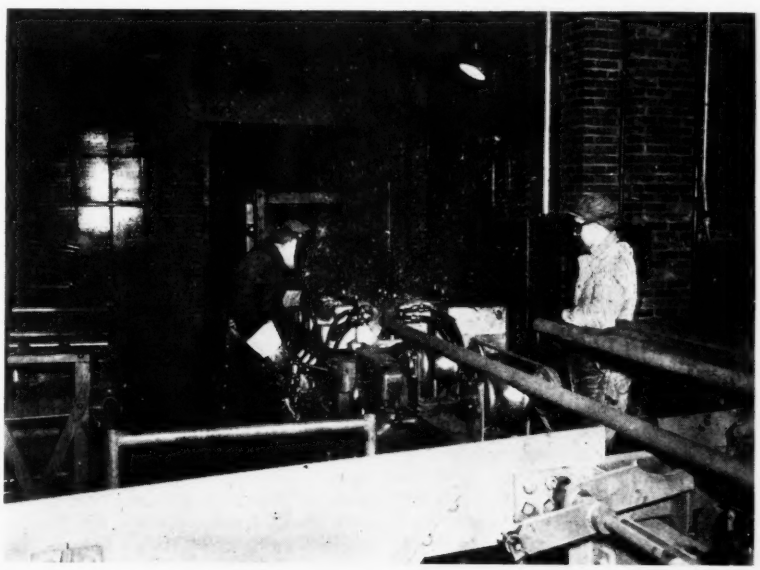
A beam of light from a photoelectric cell is established to operate an electric contactor when the Wheelabrator is ready to receive another flue. The contactor rotates three shaft-mounted cams at the end of the dirty flue rack one-tenth of a revolution, permitting the flue nearest the cleaner conveyor to drop onto angle-mounted V-shaped conveyor rolls that pass the flue into the Wheelabrator cabinet.

Flues are rotated as they pass under the abrasive wheel or blast. Their speed through the machine can be regulated between 8 and 29 ft. per min., the speed used on a given batch of flues depending upon the hardness of the scale to be removed.

The flue emerges from the Wheelabrator cabinet on conveyor rolls similar to those on which it entered. On reaching a point in line with the clean flue rack, it intercepts the beam of a photoelectric cell, which in turn operates a pneumatic elevating mechanism that lifts the flue up onto the clean flue rack. The rotating flue readily lends itself to inspection as it emerges from the cleaner.

If it is found to be pitted, or otherwise unfit for further service, the lifting mechanism normally brought into play by the electric eye is kept from operating by the attendant, and the defective flue continues along the conveyor past the rack to the scrap pile.

The new machine replaces a cleaning operation in which the flues were tumbled in revolving drums. The tumbling action resulted in numerous bent and damaged boiler flues, was slow and cumbersome, and caused excessive noise in



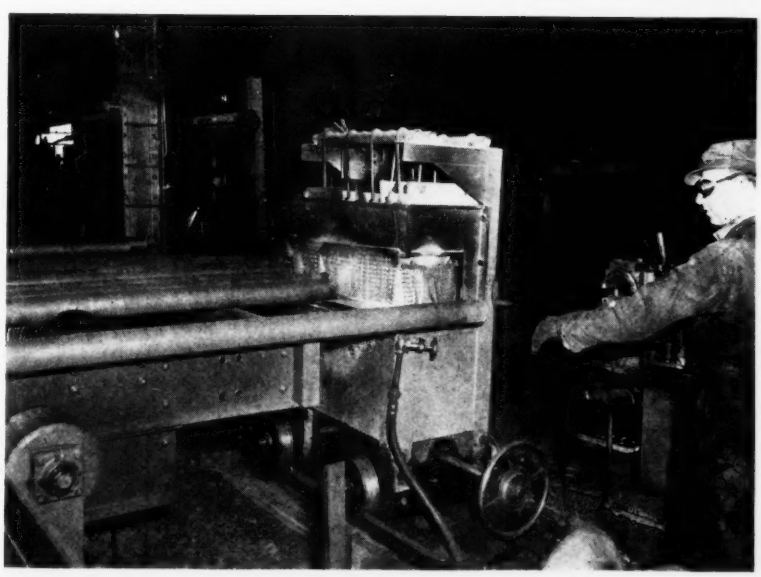


Fig. 4. (Right, above) Welding a "safe end" to a clean boiler flue

Fig. 5. (Right, below) Annealing the weld after adding a new section of tubing

the cleaning room that was undesirable—all factors that contributed to adoption of the airless blast cleaning procedure when the new shop was laid out.

The clean flue rack, to which the tube is transferred on coming from the Wheelabrator, is 113 ft. long and it has a slope of 0.35 in. per ft. of length, sloping in the opposite direction as the dirty flue rack. The cleaned flue passes first to the butt welder, at which point a piece of new material called the "safe end" is added to the end that had been cut off before the tube went to the cleaner.

Screw feeds travel between 0.8 and 5.0 r.p.m. to govern the speed of the flue through the forging operation prior to swaging. Slower speeds are used for the larger tubes. Finally, the flues pass the second cut-off saw, are annealed on the second end, and then formed.

The reconditioned flue is carried to the delivery rack by means of a series of conveyor rolls. These rolls, spaced 5 ft. apart, are arranged so that one ½-hp. motor drives two adjacent rolls. On reaching the far end of the conveyor, the flue intercepts the beam of a third photoelectric cell, starting a chain elevator that lifts the flue up onto the delivery rack where it rolls into a buggy to be returned to the erecting shop for installation in the boiler.

The department, which has been accepted as a model among boiler flue cleaning shops, was designed by, and installed under the direction of C. F. McKinney, Erie supervisor of tools and machinery.

How Coal Sizing Affects Stoker Operation*

Every engineer knows in a general way, that he must have properly sized coal to get optimum performance out of his stokers. But just why, in detail, is this so? Mr. de Lorenzi, out of a vast fund of experience shows how different types of coal on the same stoker give different fuel bed distribution, how lumps and fines act on underfeed, spreader and traveling grate stokers, how improper sizing causes trouble, the most suitable sizes for various stokers and the types of coal most suitable for each type. He reinforces his statement with test reports on specific plant installations.

By OTTO de LORENZI

Assistant General Sales Manager
Combustion Engineering Co., Inc.

IN DISCUSSION of coal sizing, lack of standard specifications is immediately evident. The terms "egg", "nut", "stove", etc. do not necessarily mean the same for bituminous coals from different fields. It has been necessary for manufacturers of fuel burning equipment to set up specifications that have general application.

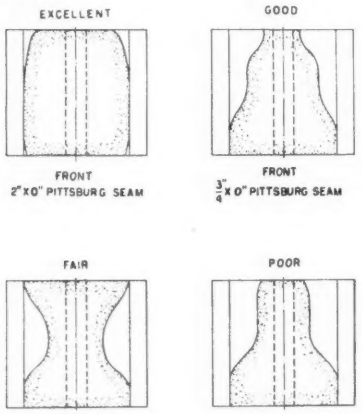


Fig. 1. Distribution of two different coals on single-retort underfeed stoker. Rate of feed to any section shown by contour, indicating stoker operation should be changed for coal size variations

For bituminous coals the most frequently used specifications are: (a) ¾ in. nut and slack (¾ in. x 0 in.); (b) 1½ in. nut and slack (1½ in. x 0 in.); (c) 2 in. nut and slack (2 in. x 0 in.).

The foregoing does not insure that the coal, regardless of origin, will be uniform in size. They simply indicate the screens through which it is prepared. The actual percentage of nut and slack will depend on the friability or relative hardness of the coal.

Recently a series of distribution tests was made on a single-retort underfeed stoker. Two different coals were used—one quite friable, the other quite hard. Thus for the same screen size the percentage of larger sizes in the first was considerably less than in the second. The reverse was true in regard to the "fines" or slack. The screen sizes were 2 in. x 0 in. and ¾ in. x 0 in. Results of these distribution tests are sketched in Fig. 1. Adjustment of the stoker mechanism was identical for all four tests.

Another indication of size influence was noted. Coal was shoveled into the stoker hopper from a pile. When the hopper ran empty it was refilled. This resulted in segregation which made its appearance in the fuel bed as series of sloping veins of coarse and fine particles. Supplying coal through a non-segregating type of downspout will minimize these difficulties.

Caking and Coking Characteristics

Coals that have a strongly caking or coking characteristic perform better when the percentage of lump is relatively high. The slack frequently will coalesce or swell. This action may blanket the fuel bed. However the lump does not generally possess this characteristic to the same degree. It thus aids in keeping the fuel bed ventilated. Agitation, by movement of the grate surface, will also assist in breaking these masses of caked or coked coal. Hand working of the fuel bed may appear to do good for the moment. However, it will eventually result in burned-out grates and excessive maintenance costs.

Some experiments now being conducted, with the object of minimizing the caking and coking characteristics of coals, will perhaps furnish the basis for a new conception of how best to burn coal and also minimize the effect of size discrepancy.

Coal on Multiple-Retort Stoker

On a multiple-retort stoker coarser coal finds its way to the tuyeres near the front part of the stoker. The fines travel the length of the retort. No lateral motion is provided to directly feed the coal onto the tuyeres.

As a result, there is a high ridge of ignited and smoldering coal over each retort. High combustion rates and thin fuel beds exist over the tuyeres. To shake down and level out these alternately thick and thin ribbons is the function of the reciprocating overfeed section. By control of this action and the admission of correct air quantities, the fuel bed may be burned out uniformly across the width of the stoker. Best results are obtained when there is a uniform gradation from lump to slack. Excessive fines makes it necessary that the majority of the burning process be carried out on the overfeed section. This means localized high combustion rates with a resulting increase in carbon loss. Readily accessible adjustments are provided so that the most suitable contour of fuel bed may be maintained regardless of fuel size variation.

The coal specifications for these stokers usually call for either the 1½ in. or 2 in. x 0 in. sizing.

Coal Sizes for Spreader Stokers

On the spreader stoker, the active fuel bed is a very thin layer and seldom contains more than a minute's supply of coal. Because only a portion of the combustion process occurs in the stationary fuel bed it is necessary to provide liberal furnace volumes. This then allows sufficient time for the fines to be completely consumed before they leave the furnace. The relative coal sizing will thus govern the amount of burning carried out by each method.

While this stoker will readily handle coal up to 1½ in. x 0 in., the standard recommended sizing is ¾ in. x 0 in. "Bug dust" and similar sizes are frequently available, and these can be handled in a most satisfactory manner.

*From a paper entitled Effect of Coal Sizing on Efficiency and Operation of Mechanical Stokers presented at the Midwest Power Conference, Chicago, Ill., April 9, 1943.

The spreader stoker is most universal in its application because it can handle with facility all coals from semi-anthracite to lignite. Anthracite has also been burned but its size range is usually confined to a narrow band that makes uniform distribution uncertain and difficult to maintain. Caking and coking qualities of coals have little effect on performance. These properties are pretty well destroyed by subjecting the fuel to the full effect of furnace temperature before it reaches the grates. As a result, there is rapid distillation of volatile matter and tarry hydrocarbons, and this almost entirely destroys the tendency to coalesce.

Even though the foregoing action is quite violent it does not prevent the larger lumps of coal from reaching the grate. If too large they cannot be completely consumed during the short "burning down" period just previous to cleaning fires. This loss may be minimized by holding the maximum screening size to ¾ in. or less.

On the other hand, as the top screen size is reduced, the amount of fine coal generally increases. This means more is burned in suspension. A considerable portion of the smaller particles, ash and partially burned fuel, will leave the furnace. Some of this "fly ash" will be deposited in the boiler passes and the remainder discharged from the stack. The carbon content of this ash represents a sizeable direct heat loss.

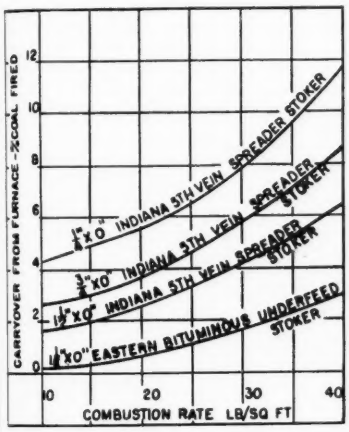


Fig. 2. Effect of coal size on stoker performance

These deposits may bring many complaints from neighbors. Consideration, therefore, must always be given to the use of a dust collector. In one or two reported instances it has been possible to minimize these deposits sufficiently to avoid nuisance complaint by changing coal size specifications. Usually this is accomplished by paying a premium for double screened, and sometimes oil treated, coal.

Regardless of this fly ash nuisance, the spreader stoker has the widest range of application. The first cost is modest, it is well suited to automatic control. Its application can be quickly made with minimum setting changes.

To show more clearly the effect of coal sizing on stoker performance the curve, Fig. 2, has been prepared. The results plotted represent the total amount of ash and combustible, in per cent of coal fired, discharged from the furnace. The combustible matter content varies from 20 per cent to 60 per cent in an almost direct ratio to the burning rate. Roughly 50 per cent of this material is collected in the boiler passes. By returning these siftings to the furnace, it is possible to recover approximately 50 per cent of their heat value.

Effect of Coal Size on Traveling Grates

Traveling-grate stokers provide a continuously moving, non-agitating, type of grate surface. Anthracite, coke breeze, lignite and "free burning" bituminous coals are ideal traveling grate fuels. Under certain conditions it has been possible also to burn some types of coking bituminous coals. Use of arches and the resulting turbulence makes possible higher liberation rates than with other stoker types.

Coal sizing plays an important part in the performance of traveling-grate stokers, probably more so than with any others because the fuel bed should be thin and possess relatively uniform resistance to air flow. If the requirement of uniform resistance is not met, many operating difficulties will immediately become evident. Perhaps the most common of these is "tonguing." The cause is segregation in the stoker hopper. The result is rapid burning out of the fuel bed at the furnace side walls, while at the center it is only partially consumed. The carbon loss in ash pit refuse will be high and the CO_2 relatively low.

Another serious condition resulting from hopper segregation is the grooving or rapid erosion of side wall and arch refractories. The low resistance of the fuel bed, adjacent to the walls, allows large quantities of air to flow through it at this point. This results in extremely high localized combustion rates and a blow torch action. Easily applied remedies are available in the form of non-segregating or continuously-swinging types of downspouts.

"Free-burning" bituminous coals are the ones most suitable for traveling grate operation. However by specifying a small range in volatile matter content and purchasing a double-screened coal it was possible, for one large plant operator, to successfully burn Eastern bituminous coals having strongly coking characteristics.

Comparisons of Stoker Operation

Comparative effect of fuel size on the performance of a traveling-grate and a spreader stoker was the subject of a recent study. The fuels tested were lignite and coke breeze. The spreader-stoker furnace was of conventional design with ample furnace volume. For the traveling grate, a rear-arch type of construction, supplemented with overfire air, was used. The first test was conducted with lignite sized to give best results on the spreader stoker. The screening was 2 in. x ¾ in. This is larger than normally recommended, but lignite has the quality of rapid weathering and disintegrating when exposed to heat. As a result the actual size reaching the grate is considerably smaller than indicated by the screening. With this fuel it was possible to develop a capacity of 250 per cent of boiler rating with the spreader stoker. The traveling grate developed 125 per cent rating. The second test used lignite "duff" which screened ⅜ in. x 0 in. In this test the spreader developed

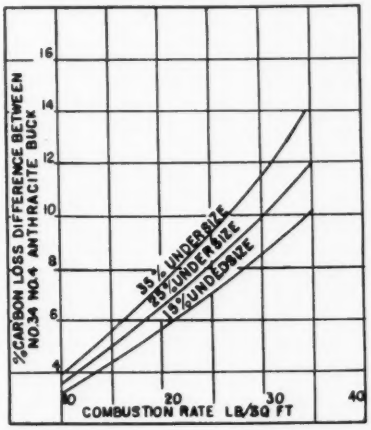


Fig. 3. Curves of carbon loss difference between No. 3 and No. 4 Buckwheat on a traveling grate

200 per cent rating and the traveling grate 175 per cent rating. A third test was conducted with coke breeze as the fuel. It screened ½ in. x 0 in. With it the spreader developed 100 per cent rating and the traveling grate 300 per cent rating.

These three tests are a striking demonstration of the influence of coal sizes on stoker performance. The engineer who conducted them suggested a lignite size of 1¼ by 0 in. as most suitable for traveling grate operation. Of particular interest are the efficiency results obtained on the traveling grate stoker fired boiler. Coke breeze was burned at a rate of 24 lb per square foot during two tests. An efficiency of 77.3 per cent was obtained on the first test. During this run the "fly ash" carried over into the third pass hopper was returned to the furnace and burned. During the second test no "fly ash" was returned to the furnace and the resulting efficiency was 74.7 per cent. There are no records available of the breeze "undersize". However had these been less than 20 per cent the "fly ash" loss would have been approximately 50 per cent less. At a combustion rate of 46 lb per sq ft, with the ⅜ by 0 in. lignite, the efficiency was 74.9 per cent. At this point it is well to point out that coke breeze is a fuel in which the volatile matter may vary from 0.5 per cent to 10 per cent. When properly sized it is ideal for the traveling grate. The normal specifications usually state that all the breeze should pass through a ¾ in. round hole screen, and that the percentage of undersize should range between 20 and 30 per cent.

(*Continued on page 99*)

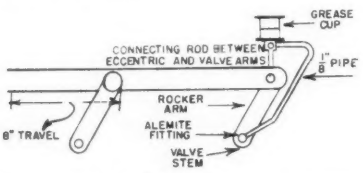
FOR THE STEAM ENGINE OPERATOR

Filling Grease Cups On Engines

By JOSEPH P. O'HERN*

A LITTLE "wrinkle" I devised for our engines that will save oil, grease and the patience of many engineers may be worth while passing on.

We have two Ball Corliss valve engines in the plant with 12 grease cups between the eccentric and the valve on each engine. These engines never stop, so it is necessary to fill the cups while in motion. They run 200 r.p.m., 8-in. travel which makes 16 in. a round trip. It will be obvious that it is no snap to fill a grease cup travelling about 300 f.p.m., so, here is what I did:



Arrangement for filling grease cups on moving parts of engines

I mounted the automatic grease cups on top of each bearing, then ran a ⅛-in. pipe from the grease cups to the center of the valve with an Alemite fitting on the end of the pipe. This fitting, it is obvious, has very little motion so it is no trouble to apply a grease gun to it.

I pass this on to other engineers so they will not have to break the Ten Commandments every time they have to fill grease cups in motion. We have effected a big saving in the use of both grease and oil.

*Chief Engineer, St. Mary of The Lake Seminary.

Valve Trouble

By G. H. KIMBALL

IN OUR PLANT we have a 17 by 16 in. high speed engine that has been installed for many years. After running very quietly for much of the time, it developed a bad pound which was laid to loose bearings but as it was not run but a small part of the time, work on it was not followed up as it should have been.

After the engineer who had been in charge of it for many years retired, efforts were made to put the engine in satisfactory condition. The cylinder was rebored and fitted with new piston and rings, the valve which was of the expansion type, was machined and the lower guide was removed and tested for wear. No perceptible wear being found the guide was replaced and when the indicator was applied, a card like Fig. 1

FIG. 1

FIG. 2

Fig. 1. Indicator diagram of engine before trouble was corrected

Fig. 2. After correcting trouble

was obtained. Before this the valve travel was adjusted by blocking out the governor but still the pounding continued.

While we were trying to think of what would remedy the situation, an engineer friend dropped in and the card was shown to him. He suggested that the fly wheel had moved on the shaft. So the governor was partly dismantled and when the end of the shaft was visible a very fine line showed that the wheel had moved about one inch around the shaft.

The hub was split and there were set screws in it. In moving the ends had become upset so that a jack was needed to move the wheel back to its original position. Then the clamping bolt was tightened up and the set screws as well as could be done. Then, a more visible mark was made on the wheel hub and the end of the crank shaft and the governor parts replaced.

After the engine was started it ran almost absolutely quiet and the card like Fig. 2 was obtained. It is apparent that these cards only give an approximate idea of the action of the valves for the indicator used was not adapted to fast moving valve gear but it was all that we had at the time.

After discovering a defect of this sort, one's memory is often refreshed and in this case, it was recalled to mind that some years priors to that time a nut had become loose in the steam chest and caught between the valve and the edge of the port. This had broken the valve rocker arm and it must have put so much strain on the governor eccentric that it caused the wheel to slip on the shaft.

This represents one of those cases where the knowledge applied was not of the type usually found in textbooks. Just what it was in the engineer's mind that suggested the thought that the flywheel might have moved is not known but the chances are that it was not a previously displaced flywheel. It was something, however, sufficiently close to enable him to suggest the correct solution. It is the accumulation of knowledge of this kind that makes an experienced operator.

Corliss Valve Gear Trouble

By ROBERT BAKER

THE FOLLOWING account of trouble with the valve gear of a Corliss engine may be of interest to others operating this type of engine. It was merely a case of two screws keeping four men guessing but for a while it was a serious matter.

These screws were in the valve area of a Corliss engine driving an ice machine. This unit had been overhauled rather thoroughly a short time before and had been operating satisfactorily until one day it began to act queerly. It would race for a while and then without warning, slow down.

Everybody had ideas about what was wrong; these ranged all the way from high water in the boiler to frost on the crank shaft but finally the trouble was found to be in the valve gear. It was merely that the screw holding the knockoff block went in too far and was making a firm contact with the inside collar. This prevented the arm carrying the knockoff block from swinging free with the governor and as a consequence, held up the whole works. Examination showed the screw in the safety catch also in too far. The trouble is depicted in the accompanying sketch. As soon as these screws were backed off the trouble disappeared and the engine performed as it had always done.

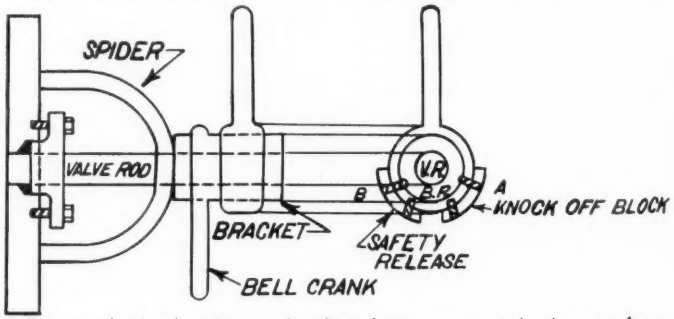


Diagram showing how improperly adjusted screws prevented valve gear from functioning properly

MECHANICAL POWER TRANSMISSION

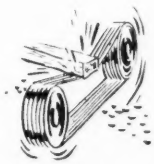
Seven Ways to Make V-Belts Last Longer

By RAY J. ENTERS
Texrope Division
Allis-Chalmers Mfg. Co.
Milwaukee, Wis.

IT HAS BECOME a patriotic obligation for American industry to keep production rolling for as many hours a day as possible . . . to squeeze every last bit of usefulness out of present equipment. Careful regular inspection of the thousands of V-belt drives now serving the nation's War Effort will protect them from needless abuse and add to their operating effectiveness and long life. Use the following check-list of common sense precautions to keep yours in fighting trim:

1 Make sure that sheaves are properly alined to prevent excess wear. Sheaves should be precisely parallel and properly lined up. Don't forget to tighten motor bolts after alining sheaves.

2 Check belt tension. Loose, sloppy V-belts wear out quicker and deliver less pulling power than taut belts. Like a violin string, properly tight V-belts have an alive springiness that means positive, efficient power transmission. Belts will last longer if tension is taken up at regular intervals.



3 Guard against needless cover wear. See that belts do not rub against floor, beams, tools, machine parts or belt guards.

4 Belt dressing should never be used for it destroys the groove-grip action of V-belts in the sheaves and causes excess slippage and wear. Belts and sheaves can be easily cleaned with water or naphtha should they become coated with harmful oil, grease or other foreign matter. For extremely oily conditions, longer belt life can be obtained by substituting special oil resisting belts.

5 Do not pry V-belts over sheave rim with bar or pipe when installing drive. This may break the internal pulling cords and, of course, result in quick belt failure. Belts will slip into sheave grooves easily if motor is loosened and moved forward.

6 Always replace V-belts in complete sets. Used belts have stretched slightly and will not pull evenly with new V-belts. They are sold in scientifically matched sets . . . each belt is machine-measured to just the proper length for perfect teamwork with other belts in the set.

7 If it becomes necessary to use a larger motor due to emergency requirements, the V-belt drive should be re-engineered for the added load. Remember, carelessness about maintaining industrial equipment today is injurious to America's all-out Victory Program. What was mere carelessness in 1940 has become inexcusable negligence in 1942.

How Coal Sizing Affects Stoker Operation

(*Continued from page* 97)

Lack of undersize retards penetration of ignition while excess of undersize increases carbon loss in "fly ash" and ash pit refuse.

A number of years ago a large coke-breeze-fired boiler plant experienced difficulty in developing guaranteed boiler capacity. The service engineer attributed the difficulty to improper fuel sizing. To demonstrate the point, a screen was placed in the bunker. The large lumps of coke were diverted to one boiler, while another received the smaller sizes. The first boiler could hardly develop rating and it was necessary to operate with pressure in the furnace to maintain ignition. The second boiler operated at above 275 per cent rating with a slight draft in the furnace and no indication of "touchy" ignition. The presence of large lumps of coke retarded ignition. They were actually discharged to the ashpit without being burned. As a result the plant screens were repaired. The reclaimed domestic size of coke was sold. Ample steam was generated with the remaining breeze.

Performance of Anthracite

Anthracite is the fuel on which there is perhaps the greatest amount of data covering the effect of sizing. Synonymous with anthracite is the name Coxe stoker. The pioneering developments of Eckly B. Coxe are responsible for the use of fuel sizes that were once considered a total loss. Number 3 Buckwheat, Barley, No. 4 Buck, River Coal, Anthrafine, Culm, Silt, etc. are some of the names that designate size classifications. The most commonly known and used are No. 3 and No. 4 Buck and River Coal. When these smaller sizes of anthracite first came into prominence as steam plant fuels, operating results were inconsistent. Finally it became evident that the varying percentages of undersized fuel was responsible.

Because of the success in burning No. 3 Buckwheat the next step was to use No. 4 Buck and River Coal. When these fuels were burned in the standard front-arch type of furnace, efficiencies were very low. After a series of furnace design developments, the rear arch type furnace was developed. In these furnaces ignition is positive and penetrates the fuel bed rapidly.

The curves of Fig. 3 show the carbon loss difference between No. 3 and No. 4 Buckwheat, with varying percentages of undersize, on a traveling grate stoker installed in a rear arch type of furnace. The use of a cinder-return system will reduce the difference because there is more recoverable fuel available as "fly ash" with No. 4 Buckwhat than with No. 3.

Each type of stoker equipment, regardless of manufacture, will perform best with a limited size range. Sometimes, by paying a premium for a more favorable sizing, it will be possible to obtain overall results that more than justify the higher cost.

LETTERS AND COMMENTS

Help on Training Operators

UNFORTUNATELY adequate training programs for power operators seem to be rare and far between. Due perhaps to a multiplicity of reasons that are not always the fault of the management, supervision, or the individual, but the general fault of all concerned.

A vacancy will occur in the Power Department so the Personnel Department selects a prospective operator, who is subsequently interviewed by the Superintendent of Power, and hired because he seems to be energetic, ambitious, and so forth. But all too many operators being hired today look upon power plant operation as just another job, instead of a very interesting and technical profession, consequently the operator is satisfied to work 8 hours and go home, forgetting about his job until the next day. The management realizes these facts but the pressure of work forces the transfer and responsibility of training to the supervision. Herein the main trouble occurs.

For example, a shift supervisor will instruct an operator regarding the mechanics of the equipment he operates and backs up his statements by his years of experience. The operator, being doubtful about what this supervisor told him, will question another supervisor and receive a different opinion that creates a conflict in his mind as to what is really correct. Thus the operator's progress toward basic truths and good operation is and continues to be delayed.

To remedy this woeful situation it would be well worth while, for any management and supervisory body, to organize an intelligent, comprehensive training program, to which all experienced operators could contribute. The results would be beneficial to the entire organization.

The management and supervision should set up an operational procedure applicable to each mechanism in the power plant. These procedures could be in mimeographed bulletin form and distributed to each operator. Each bulletin to state exactly what is expected of the operator and the step by step action to be taken to satisfactorily perform any operation pertinent to the machinery being operated.

A great deal of conflicting information could thus be eliminated and the eventual returns would be, "Well Trained Power Plant Operators."

DONALD L. GUSLER
Morgantown, W. Va.

Forced Draft—Round and Round It Goes

REPLYING to Mr. Patterson's comments in the February, 1943 issue, may I say that Mr. Patterson's statement concerning what he says is one of the largest corrections in selecting a forced draft fan, is most amazing. He says I missed the point in not considering the air which leaks into the furnace and says that this amount of air is "*subtracted from*, not added to, the calculated volume since it is air which takes part in combustion but is not supplied by forced draft."

During many years of experience with forced and induced draft, not only in charge of sales, but as a trouble shooter, I must confess that I never heard of anyone trying to figure forced draft requirements by subtracting estimated furnace leakage from the calculated forced draft requirements. Such procedure would be absurd.

In most cases the air which leaks into the furnace is above the fire or along the sides of the stoker and only a very small amount of this air actually gets into the combustion reaction. Even if this air should leak into the furnace through the front wall, directly above the fire, it is extremely doubtful if any appreciable amount will enter into the combustion reaction since it does not enter the furnace at high velocity. Such air will stratify and will not mix, to any appreciable extent, with unburned gases. Overfire air, to be effective in overcoming smoke and incomplete combustion, must be injected at very high velocity. This is one of the reasons why steam jets are often used for this purpose.

Furnace leakage should enter into induced draft fan calculations and this is why, in many instances that the induced draft fan, guaranteed to deliver a certain volume at a specified temperature and static pressure, is overloaded and is wrongfully accused of failure to perform. I have encountered many such cases.

Returning to our forced draft problem, I can enumerate many cases where the fan was blamed for not delivering the required amount of air for combustion but was exonerated when it was found that the air was leaking through porous concrete ducts before it reached the combustion zone. Other peculiar construction and operating errors could be related but that is another story. In the May and December issues of 1936, pp. 270-272 and 690-693 I told of a few of my experiences in mechanical draft trouble shooting but space here does not permit detailed discussion of fan troubles. In the February, 1939 issue, pp. 111-112 I discussed forced draft for underfeed stokers.

Mr. Patterson admits that fans often are picked for volumes and pressures of as much as 25 per cent in excess of calculated requirements. Since this is true, why do they *add* to the volume and not subtract? The answer is obvious. The engineer wants to allow for air leakage through ducts and around the grates before the air reaches the combustion zone.

I shall be most interested in learning if there is any fan company which tells its prospective customers to *deduct* for air infiltration to the furnace when figuring forced draft fan performance.

Further, as was pointed out in my 1939 article, if the fan is picked for a volume 25 per cent in excess of calculated requirements, the pressure should not be figured at 25 per cent excess if the fuel is not burned on grates or stokers. For oil, gas or powdered fuels the pressure varies as the square of the volume. For example, if the calculated requirements were 50,000 c.f.m. at 2.0 in. static pressure and the volume is boosted 25 per cent, the fan must be picked for 62,500 c.f.m. at 3.14 in. On the other hand, for stoker firing the pressure varies directly as the volume changes and the volume would be 62,500 c.f.m. at 2.5 in.

Naperville, Illinois J. R. DARNELL

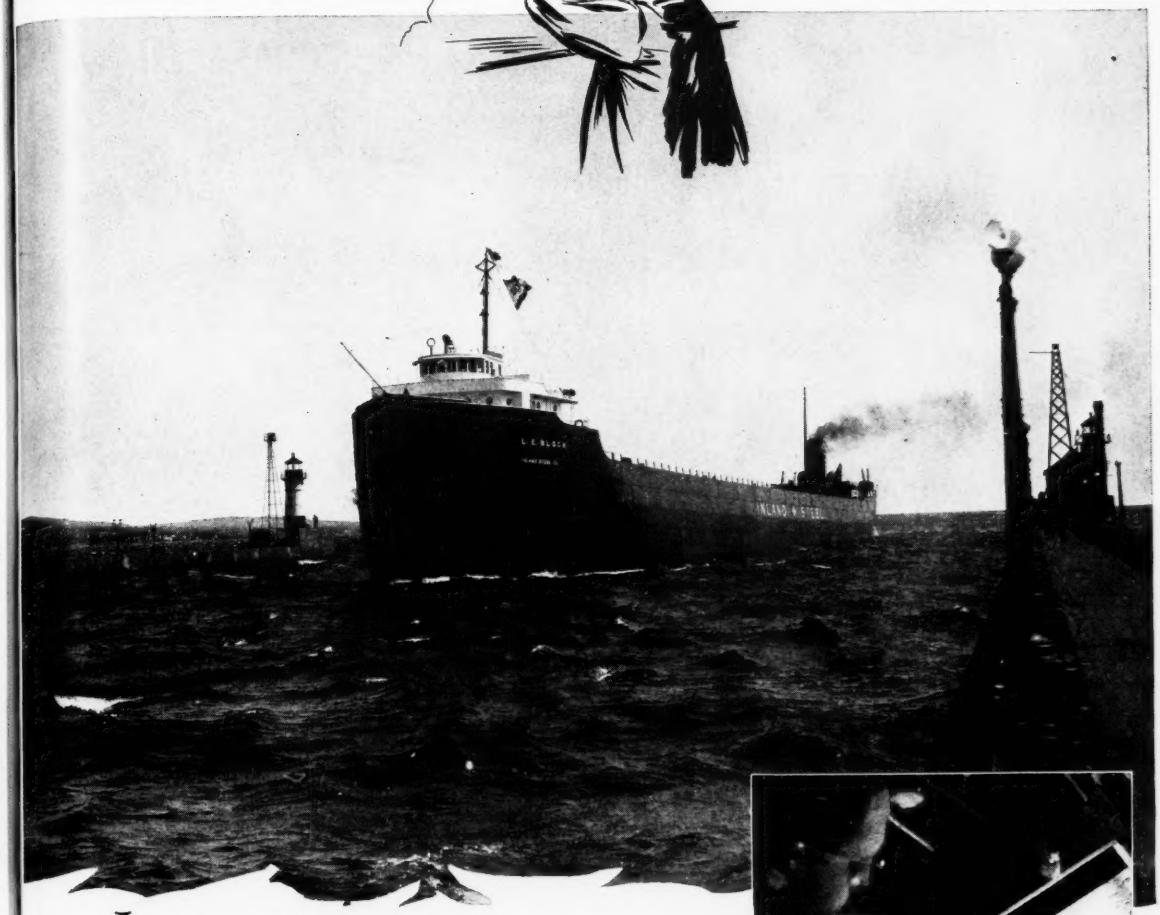
Comments on Simplex Pump Operation

C. E. D.'s query regarding his simplex pump was interesting to me. As a greaseball in a coal mine the first pump I ever operated was of this type. It was used to dewater the cage sump. Steam for it was led down the shaft from the boiler room on top. In more than one place the insulation had fallen off the pipe, and where the line turned horizontal at the bottom nothing but an old piece of sheet metal kept the ground water streaming down the shaft from splashing directly upon it.

In a way, this condition of the insulation was beneficial. It gave ample assurance that no superheated steam would reach the pump and damage it in any way, say by drying out the wooden plugs driven into the holes

(*Continued on page* 102)

FLOATING BOILERS *Can't take time out!*



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Letters and Comments

(Continued from page 100)

where the bleeders should have been, and letting them blow out. Also, superheated steam might have carbonized the lubricating oil. There was a lubricator on the pump, and I sometimes filled it with the same 600-W I used to grease the mine cars. It was the only oil ever brought below ground. Using it for cylinder oil was very economical, as the pump had to get pretty hot before the oil would get thin enough for the lubricator to handle. Either the lubricator plungers sucked uselessly up and down, or the little pawl slid forlornly over the teeth in the ratchet wheel. As a result, very little oil was used.

At times, especially in the spring and fall when ground water was abundant, this not so simple little simplex pump ran night and day. Since this was a small mine, there was no night shift. Between the time the shot-firers came on top in the evening and the time the examiner went below next morning, no one entered the mine. That is, no one did until this pump began to fail. Then the engineer on duty took to sending the watchman below once or twice to look the pump over. But in spite of this inspection there were times when I went below of mornings to find the pump stopped and the sump and run-around full of water.

I was 17 yr old at the time. Possibly for this reason my method of getting the pump started was somewhat unique. I first opened the valve in the steam line to my vat of 600-W. This let the 190 ft length of 1¼-in. vertical steam pipe empty itself of water, at least down to the tee where the branch to the oil vat turned off. After making sure that all valves about the pump were open, I took a bar from a jim crow and pried the piston rod back and forth. Sometimes this maneuver would get the pump to start. In case it didn't start, I kicked it a few times, especially jarring the chamber of the steam-thrown valve. It was astonishing how often this simple remedy worked. The pump would make two or three quick strokes, slamming the piston against the heads. Then it would settle down and empty the sump in no time.

But there comes a time in the life of a machine when even the most simple remedy will fail right along with the complex ones. One morning this pump refused to function, and no amount of my prying and kicking would start it. The pit boss and cager, whom I called to my assistance, were unable to do any better than I had. A hoisting engineer came below, and also failed to make the pump take steam.

The pump was dismantled. It was of the inside* geared type, with little auxiliary piston valves used to reverse the steam-thrown piston valve. The engineer pointed out that the stem of one of these little pistons was too short, and that on a slow stroke against high head pressure on the water end, the main piston would not move far enough to touch the stem and push the little piston into its open position.

I don't remember whether the stem was adjustable, or a new one had to be put in. But thereafter the pump started and ran without trouble, and with a great saving in shoe heels for me.

Marissa, Illinois — GEORGE HOLMAN

*reversing gear

Removing Balky Pump Valves

I recently had a dose of stuck valves in a big Dean outside end packed pot valve pump where all the valves were too tight except one. That poem on page 90 fitted the case perfectly. This is a second hand (reconditioned?) pump and for a long time worked very well as a boiler feeder handling water at anywhere from 180 to 220 temperature. Then one day the whole flock of valves stuck and we had to rip the pump apart and drive most of them out. Some fun.

These valves are of the vane type and we ground the vanes down a bit and they still stuck until we found a slight shoulder on the vane right up near the body of the seat. As soon as we got rid of the shoulder we heard no more from these valves.

And now please turn to page 88 of the January issue and gaze on that article by Mr. P. C. Ziemke. For the life of me I don't see how we are going to get that puller under a stuck valve when the valve is stuck tight on the seat.

Buffalo, N. Y. — R. G. SUMMERS

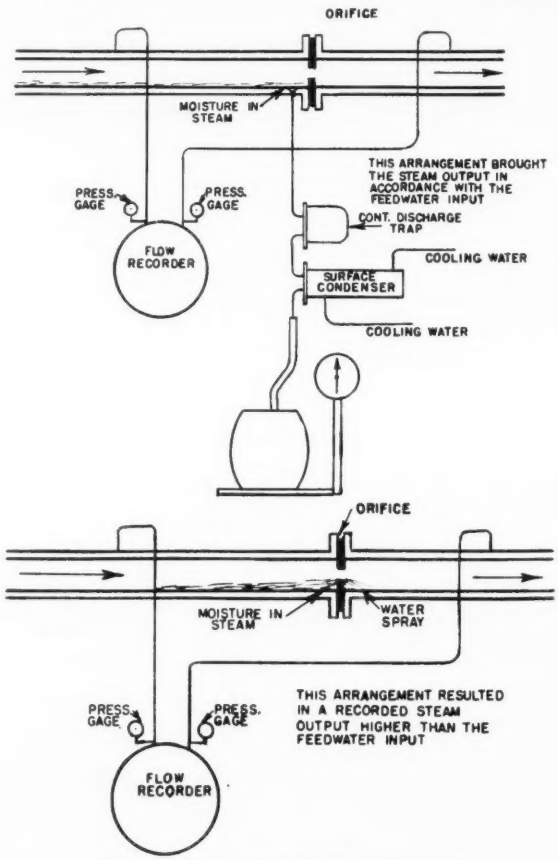
Flow Meter Operation

REGARDING the series of articles entitled, "Why, How, and Where of Flow Meter Installations" by W. C. Bennett, which appeared in these pages recently, I missed seeing any reference to a rather important point.

A long time ago in another plant in which I was employed, the readings obtained from a perfectly new and high priced steam flow meter did not seem to coincide with the readings of the feedwater meter. The idea of installing the flow recorder was to check the steam output while the feedwater meter measured the water input to the same boiler. It was obvious that one of the measuring instruments was out of step. After thinking about the matter for some time I made an experiment, as shown in the self-explaining diagram, herewith, which showed definitely that the trouble was not with the feedwater meter.

HERBERT ETTELT

EDITOR'S NOTE: It seems to us that the orifice was too small. A larger orifice would not have permitted this condition to exist.



Diagrams showing how the accumulation of moisture behind an orifice resulted in incorrect flow meter readings

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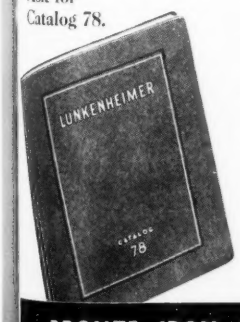

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BRONZE, IRON, STEEL AND CORROSION RESISTANT ALLOY VALVES, 125 TO 2500 LB. S.P.; BOILER MOUNTINGS, LUBRICATING DEVICES, AIRCRAFT FITTINGS

Questions And Answers

Question No. 227

What Makes the Power Factor Needle Swing?

I am wondering what will cause the power factor needle to keep swinging from about 90 lag to about 90 lead when all the rest of the meters seem to stay put. This power factor meter is on the board that feeds the motor generator set consisting of a d.c. generator driven by a synchronous motor.
Buffalo, N. Y. R. G. S.

Question No. 228

How Big Should Pump Discharge Line Be?

I AM INSTALLING a Dean duplex pump, 7 by 4 by 10 in. The pump has a 4-in. supply and a 3-in. discharge to the boiler. The supply has a 4 ft. head. I reduced the supply to 2½ in. and the discharge from 3 in. to 1½ in. to the boiler, and feeding into the 2½-in. blowoff. The boiler is 16 by 18 ft. tubular, 100 hp., 90 psi.; evaporates 30 lb. of water per horsepower, feedwater at 130 deg. F. Would it have been proper to run a 2½-in. supply line from pump to boiler, or is 1½-in. supply O. K.? What difference is there in the friction of 1½ and 2½ in. pipe at 90 psi. boiler pressure?
Oak Park, Ill. E. G. S.

Question No. 229

Why Does Hot Well Level Vary with Steady Load?

I AM IN CHARGE of a 550-kva, 7200-v De Laval condensing turbine generator, with bleeder connection for 35 lb, throttle steam pressure 200 lb. My problem is: What is the cause of the hot well water level fluctuating from ½ in. to 8 in. on a steady load? The condensate pump is motor driven, constant speed, discharges from hot well through jet jump to heating pump return line, for cooling of heating returns to pump and partly direct to our open feedwater heater. Jet pump temperature was formerly carried at 140 F by control of cooling water and carried a vacuum of 27 in. Now 106 F is all we get, with 25.2 in. vacuum. Over this temperature, the vacuum gets lower. The condenser was retubed in March, 1943, lower stage diaphragm in turbine December, 1942.

What can cause this condition? Can pump capacity increase or decrease? Enclosed are a few readings which may be helpful. Circulating water pumped through condenser by a 750-gal constant-speed motor-driven centrifugal pump to cooling tower on roof.
Elmhurst, N. Y. W. K.

Answer No. 208

Removing Sludge from Refrigerating System

We have been having trouble with the formation of sludge in our refrigeration system, said F. McL. in the December issue and asked what causes it and how to remove it.

C. T. Baker and Edmund T. Bonnelt gave him some good advice on this problem in the March issue and now here comes George Deichman with some more. This is all straight stuff from men who have had experience with the difficulty.

Typical readings from W. K.'s condenser auxiliaries

Steam Pressure	KW	Vac.	Temp. Water In	Temp. Water Out	Jet Temp.	Press. Jet Steam	Time
190	150	28.2	52	65	104	135	1
"	130	28.	52	64	104	135	2
200	120	28.	50	62	104	135	3
"	130	28.	54	66	104	135	4
"	180	28.	58	73	106	135	5
"	180	27.7	60	75	106	135	6
"	250	27.5	67	85	106	135	7
"	390	26.1	68	97	106	135	8
"	390	25.1	78	103	106	138	9
"	410	25.2	81	107	104	138	10
"	420	25.1	82	107	106	135	11
"	330	25.3	80	107	106	138	12
200	400	25.2	84	108	106	140	1
"	400	25.1	83	109	106	140	2
190	400	26.6	82	107	104	137	3

Help! Help!

Question No. 230

How Stop Bearing Failures on 475-hp Diesel?

WE HAVE trouble with failure of the main bearings on a 475-hp, 11 by 18-in., 8-cyl, 365-rpm Diesel engine. Can POWER PLANT ENGINEERING's readers help us? We need it badly. Here's the story.

These bearings are cracking up very rapidly, some lasting only three weeks. The cracks are very jagged and have no particular direction whatever. They go clear down to the bond and after they form small islands in the bearings, these islands raise up and are dragged by the shaft. This cracking is not confined to any particular bearing or cap, going from one to another promiscuously. We were cracking base bolts till the first of the year. After having the engine realined this was corrected but after three weeks of running, the center main bearing had to be replaced. We have the generator pedestal completely insulated; the frame of the engine has been grounded on the assumption we were getting stray currents through the frame. Different types of bonding have been tried, all to no avail. Any wiping of the bearing metal is not caused by tightness of the bearing but occurs only where the babbitt leaves the bearing.

If anyone has had similar experience and has been able to cure the trouble, I would greatly appreciate it if he would tell me about it.
Detroit, Mich. F. E.

Deichmann Tells 7 Things to Do

This trouble has several causes. (1) Bad rings in compressor, causing pumping of oil from the crank case of the compressor into the system, also lack of an oil trap in the system. (2) Poor grade of oil. (3) Too much refrigeration coming back to the compressor, causing the saturated or moist gas coming back to the compressor to liquefy and drop past the rings into the crankcase, which also helps to kill the life of the ammonia and oil. (4) Working the system under a vacuum, pulling air into the system and pulling moisture in with it. The moisture is condensed into the system. This comes back to the compressor and drops into the crankcase causing the oil and water to mix producing a slush or sludge, which is then discharged into the system. Slush and oil in the system will act as an insulator and cut down your refrigeration efficiency.

Remedy

(1) Take your compressor apart, check your cylinders to see that they are not egg-shaped.

(2) Put in a good set of oil rings.

(3) Check your suctions and discharge valves to see that they are not leaking.

(4) Put a good grade of oil in the crankcase. If it is an ammonia system, use ammonia oil, or the proper kind of

EDWARD FORGED STEEL RELIEF VALVES

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LIKE ALL valves in the Edward line, Edward relief valves are simple, functional and sturdy in design. There are only a few parts, all precision-built to withstand severe service. Body is forged steel, bonnet rolled steel. Renewable stainless steel seat and accurately ground stainless steel ball disk for tight seating. Rolled steel screw cap is vapor proof. Fine carbon steel spring of adequate length for full relief area when discharging.

Size—Fig. 141	Dimensions in Inches		Weight, Lb.
	Center to end	Center to top	
¼ & ⅜	1½	6½	2½
½	1⅞	7¾	4¾
¾	2⅛	9½	6¼
1	2⅜	10	13
1¼	2¾	12¼	19½
1½	3⅛	14¼	30½
2	3¾	16	40

INQUIRIES should include information concerning service, frequency of operation and relieving pressure desired. For additional details on relief valves and other cast and forged steel valves in the Edward line write for Edward BETTER VALVES Catalog No. 101.

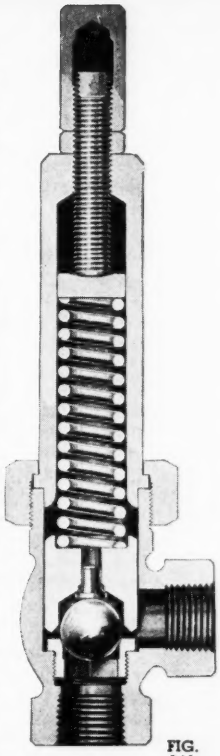

FIG. 141

TO PROTECT EQUIPMENT against abnormal increase in pressure, choose Edward steel relief valves.

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CAST AND FORGED

oil for the the particular system.

(5) See that you have an oil trap between the compressor and the condenser with a valve in it so you can drain the trap about once a week.

(6) Do not work your system under a vacuum unless you want to pump the system out for repairs.

(7) Do not open your expansion valve too far for the refrigeration to go to the compressor. The farthest the refrigeration frost should go is to the end of the suction coil.

New Orleans, La. GEORGE DEICHMANN
Falstaff Brewing Plant No. 4

Answer No. 209

What Makes His Oil Foam?

Fred Hartmann, in the January issue, asked what makes the oil foam when the bearing rings start to turn in his 200-kw., 1200-r.p.m. synchronous converters. He asked if it was the oil or some mechanical condition that caused it and if oil should foam like this in bearings. Below is what our good friend J. W. Lawyer has to say. He doesn't think it means much in this particular case but he explains the cause of it and tells three things Hartmann can do to reduce the foaming.

It Isn't Serious, Says Lawyer, and You Can Reduce It

MR. HARTMANN says that he does not know whether the foaming of his bearing oil is caused by the condition of the particular oil he is using or if it is caused by some mechanical condition of the machine. The answer is that either, or a combination of the two conditions, could cause the foaming. The writer will answer the question in an elementary way so that it will easily be understood.

All oils have a surface tension or skin. The strength or toughness of the skin depends upon the viscosity and temperature of the oil. In other words, the heavier the oil the stronger the skin and, as the temperature of the oil is raised from atmospheric, the skin becomes weaker. When drops of oil fall from the bearing down into the main body of the oil, they cause air to be entrained, which forms bubbles. The larger the drops, the longer the fall and the colder the oil is, the more foam will be created. Generally, bearing oils that foam at atmospheric temperatures will cease to foam when subjected to operating temperatures of 150 to 160 deg. F.

From the information given in this case, it is our opinion that the foam experienced is of no significance. However, there are three things that can be done to reduce the foaming in this or similar cases. (1) Use a lighter grade of oil. (2) The oil, in returning from the bearing, should not fall or splash into the main body of oil but should slide down the side of the metal plate, the lower edge being in the main body of oil. (3) Raise operating temperature of oil.

San Francisco, Calif. J. W. LAWYER

Answer 210

Looks Like Something Rotten in Denmark

ROBERT BAKER connected some new transformers on his lighting system, but they knocked his power factor from 95-97 down to 75-85. And to add insult to injury they blew out pilot lights in his demand meter and watt-hour meter and shoved the pen clear across the chart and held it there. And the last straw; one transformer was hotter than the other and nobody could tell him why.

His original transformers, badly overloaded, consisted of 3 single-phase units, rated at 15 kv-a., 2200-v. primary, 115-v. secondary with split secondaries in parallel. With these units in service, and a 150-hp. and 175-hp. synchronous motor on the line, power factor was 95-97 per cent. After the new units were connected, with primaries direct to the 2300-v. line between the oil circuit breaker and the power company's cutout, power factor dropped to 75-85 per cent and they had to cut exciter voltage to get it back to its former value. Here's what Sam Williams and Carl Bachmann have to say about it.

New Transformer Not Wired Right

REGARDING Mr. Baker's transformer question, I believe that the warm transformer is wired in such a manner that its output is not of the same polarity as the other two. This would account for its increased operating temperature and the false readings of the various meters.

It also could be that the warmest transformer is not of the same ratio of voltage transformation, or is not of the same impedance, as its fellows. This being the case, all three would not work together in harmony.

Wingdale, N. Y. SAM WILLIAMS

It May Be Incorrect Wiring, Says Bachmann

I AM INCLINED to treat the last question first: Why is one transformer warmer than the other two? He omitted to state whether the replaced transformer bank is second hand or new. If second hand, check oil level, sludge or other impurities, which can cause insulation breakdown. Needless to say, transformers should be of the same design. However, if new and connected properly, the temperature differential may be due to the impedance which should be the same for the three transformers. Perhaps using a reactor would increase the impedance rating of the unit with the low impedance to a value equal to the other units.

In addition I should like to add that transformers are rated kilovolt-amperes instead of kilowatts, kilovolt-amperes times power factor = kilowatts.

Now we shall treat the question of pilot bulbs and recording pen. Beyond any doubt, due to some manipulation, phasing out, parallel connection, or voltage ratio of the three units must be the same. Otherwise current will circulate within the delta, voltage impression will be too high, if only for a fraction of a second, which is sufficient for blowing and sometimes exploding pilot bulbs. This also applied to the recording pen, hence the overtravel.

Now the power factor problem: 75-85 is considered GOOD. What caused the drop of power factor compared with the previous transformer bank? I shall try to explain it simply. Compare any machine that is overmotored and one that is under-motored, decreasing the power factor in the first and increasing the power factor to a certain extent in the second case. Mr. Baker is very fortunate indeed to have synchronous motors, which can be utilized to improve power factor to the desired value if it is economical to do so.

Also, since the previous transformers have been replaced on account of overload, he may as well check the feeders, which many times do not receive the required attention in such alterations.

Schenectady, N. Y. CARL BACHMANN

Answer No. 212

Why the Large CO_2 Difference?

Orsat tests on a 3-drum, bent-tube, oil-fired natural draft boiler, with setting in good condition, showed 13.5 to 14.2 per cent CO_2 in the furnace gases but only 9 to 9.5 per cent CO_2 in the stack gases a foot ahead of the damper. H. Ettelt wanted to know if they shouldn't be the same and if the trouble might be caused by steam atomizing oil burners.

Brown, in reply, suggests air leaks despite Ettelt's comment that there aren't any and suggests where to look. He doesn't think the burners have anything to do with it. Martin Gozdenovitch suggests checking instruments, comments on burners and oil firing in general and says stack readings will always differ from those in the passes.

Look More Carefully for Air Leaks, Brown Suggests

A large difference in CO_2 readings usually indicates an air leak either in furnace, boiler setting or in sampling pipes leading to the Orsat.

I suggest that Mr. Ettelt make a careful inspection of his furnace and boiler setting from the inside when the boiler is out of service.

Sometimes a cleanout door in an out-of-the-way place is left partly open or there may be a hole in the baffling that allows air to pass through the boiler without being mixed with the combustion gases.

A leak in the sampling line to the Orsat also will give the same results and sometimes the leaks are hard to locate.

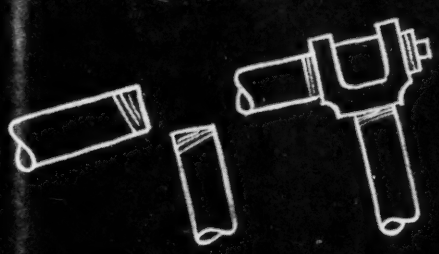
If the gas sample from over the fire were not cooled before being drawn into the Orsat, the cooling of the gases while the CO_2 was being absorbed would cause the reading to be too high.

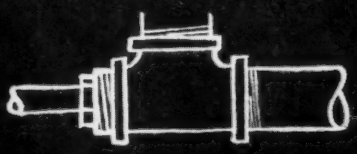
If the flue gases are cooled to room temperature before they are passed to the absorption chamber of the Orsat, the steam used for atomizing the oil will not have any effect on the reading.

Lombard, Ill. HAROLD D. BROWN

LESSONS FOR TRAINEES

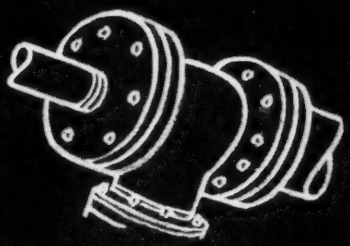
WARTIME PIPING INGENUITY!





SAVING A JOB WITH BUSHINGS

WHEN YOU'RE SHORT AN ELBOW



HOW TO MAKE A SCREWED REDUCING FLANGE

TIPS ON VALVE TRIM
TO HELP KEEP PIPING ON THE JOB
How to Repair Valves
11 SIMPLE WAYS TO GET BETTER SERVICE FROM PIPING EQUIPMENT
Short-Cuts to Faster Piping Jobs
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ARMY E NAVY

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Calibrate Instruments and Adjust Combustion Equipment Properly

CO_2 readings alone are not a correct indication of the efficient operation of a steam generator. The first thing to take into consideration would be a thorough check-up of the CO_2 indicating and recording instruments. Too much stress cannot be laid on the importance of having the metering apparatus calibrated. After this procedure a complete analysis should be taken of the flue gases.

With a case of insufficient air, low CO_2 and high CO will result in incomplete combustion; so that the furnace gases do not reach a higher temperature as would be the case in theoretically complete combustion.

If the air supply is increased, the CO_2 will also increase. Furnace temperatures should be raised by decreasing CO up to the point where it disappears.

When the air supply is raised above this point, the amount of heat required to bring the furnace temperature up will be greater, resulting in a lower temperature reading in the furnace gases. The CO_2 reading will then be much lower because the gases will be diluted with excess air.

Care must be taken of the steam atomizing burners, by checking them for uniform spraying of the oil. Burners should be adjusted to give off a fog-like spray.

Air registers should be adjusted so that the incoming air will mix thoroughly with the fuel-oil spray. Thoroughness of this mixture will reduce the percentage of excess air admitted through the furnace.

The position of the atomizer is very important. Operators have a tendency to push them in too far. Burners will operate better if withdrawn as far as possible, even though this may require extra draft. Atomizers shoved in too far will result in a higher reading of CO because the fuel-oil spray will not mix properly with the air. For every pound of fuel-oil burned, approximately 15 lb. of air are needed.

Clear stacks are deceiving. The supply of air at the burners should be reduced until a light brown haze issues from the smoke stack; provided, of course, there are no dirty or streaky atomizers. If the flame is dazzling white and the walls may be seen, there is considerable excess air. With the least possible excess air, the ends of the flames farthest from the burners are a yellowish orange or golden shade and the seams in the brick wall can just be seen.

When in operation the flame must just clear the inner face of the furnace opening brick cone. Temperature of the fuel-oil will depend on the type of oil used, and the fuel-oil pressure should not exceed the amount the burner was designed for.

Adjustments of the steam atomizers are done with proper attention and experiments (no cussing). Of course, an inefficient installation may be a serious source of hair pulling.

Another point to watch for is unconsumed oil striking cooling surfaces.

Poorly-designed furnaces may frequently cause smoke when the air supplied is very much too much in excess.

Re-designing the furnace will pay dividends and should be done before an efficient oil and air regulation can be realized.

Stack readings will always be different from those in the passes, due to incomplete mixture of air and the hot gases, because of the great turbulence created in that area.

Fairview, N. J. MARTIN N. GOZDENOVICH

Answer No. 218

Shrinking a Steel Cylinder Onto a C.I. Cylinder

IN THE March issue, S. S. asked how to figure the diameters in shrinking a steel cylinder onto a cast iron cylinder. Perhaps these should have been called tubes instead of cylinders, for a cylinder is solid. But the word cylinder has so long been used to mean a certain thing in power engineering that no reader misunderstood the question. Shrinking of liners into cylinders and other applications of shrink fits come to mind.

Charles Hubbard says he has found a very practical application of the computations for shrink fits in estimating the force necessary to pull a stern tube into the stern frame of a vessel.

Mr. Hubbard calculates the required diameters by the A. S. M. E. formulas and this involves assuming a difference in the diameters and then calculating the stresses to see if they are within the allowable limits of both materials. George Deichmann gives brief but clear instructions, omitting the calculations. Finally, Terry Mitchell gives instructions for doing the job by shrinking the cast-iron cylinder with dry ice (CO_2 snow) a technique used by many manufacturers today.

Instructions from Deichmann

To shrink a steel cylinder on a cast iron cylinder, the average scale for shrinking and expansion is one-thousandths to a square inch and to shrink this steel cylinder on to a cast iron cylinder the cast iron cylinder outside diameter must be 6 thousandths of an inch larger than the inside diameter of the steel cylinder.

There is no special formula on heating. With the cast iron cylinder at normal temperature, heat the steel around the end of the cylinder until it is just about to turn red, then slip the steel cylinder over the cast cylinder and pour a little water over it to get the majority of the heat out of the steel cylinder. Then let it cool off by itself.

New Orleans, La. GEORGE DEICHMANN

Terry Mitchell Shows How to Do It with Dry Ice

YOU CAN also make the tight fit, wanted by S. S. of Bronxville, by shrinking the inside cylinder with dry ice. The temperature of this carbon dioxide "snow" is some 110 deg. below zero, F. You can figure that a cylinder liner of hard cast iron, measuring 6 in. across, will shrink from 7 to 9 thousandths of an inch in diameter, when chilled with the snow. The exact amount will vary with the material, and with how well it is cooled. If the liner remains packed inside and out with snow for three hours, it should be sufficiently chilled.

When shrinking the internal cylinder or liner, it is assumed that the interior diameter of the outer steel cylinder is exactly 6 in. But if the liner is turned say 0.008 in. oversize and then chilled, it will not slide freely into the outer cylinder. Four or five thousandths clearance will be needed for sliding, depending on how long and how straight and smooth the cylinders are. (One rule of thumb says to allow one thousandth per inch of diameter for a sliding fit.) Hence the liner could only be made from two to five thousandths oversize. Three thousandths "large" would be safe.

If the cylinders are long, or a very tight fit is wanted, the outer piece can be heated somewhat while the inner one is being cooled. Lower the inner cylinder, while still filled with snow, into the larger one, which should be standing in a vertical position. The stretch required of the outer shell, when the inner one is made oversize but with allowance for sliding, is well within the elastic limit of steel.

Waynesboro, Pa. TERRY MITCHELL

Calculations by A. S. M. E. Method

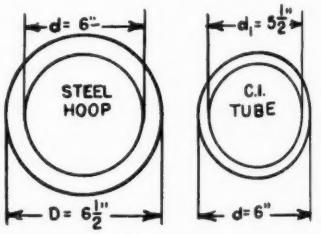
FORMULAS for determining the stress in hoops and tubes when these are not of the same metal can be found in

Transactions of A. S. M. E. Vol. 59—1937. Article on Press & Shrink Fits. Page A-183. By O. J. Horger and C. W. Nelson.

Formulas are given in Tables 1 and 2 —Pages 184-185 A. To obtain the stress in the hoop and tube; it is necessary to use two formulas—one is complex.

For this particular problem, the approximate value given below gives approximately the same values as the formula.

Since the hoop and tube wells are relatively thin compared with the diameter, the stress can be assumed to be evenly distributed across the hoop and tube.



Basic equation

$$E = S \div (e/l) \qquad (1)$$

Where E = Young's Modulus of Elasticity

30,000,000 for steel

15,000,000 for cast iron

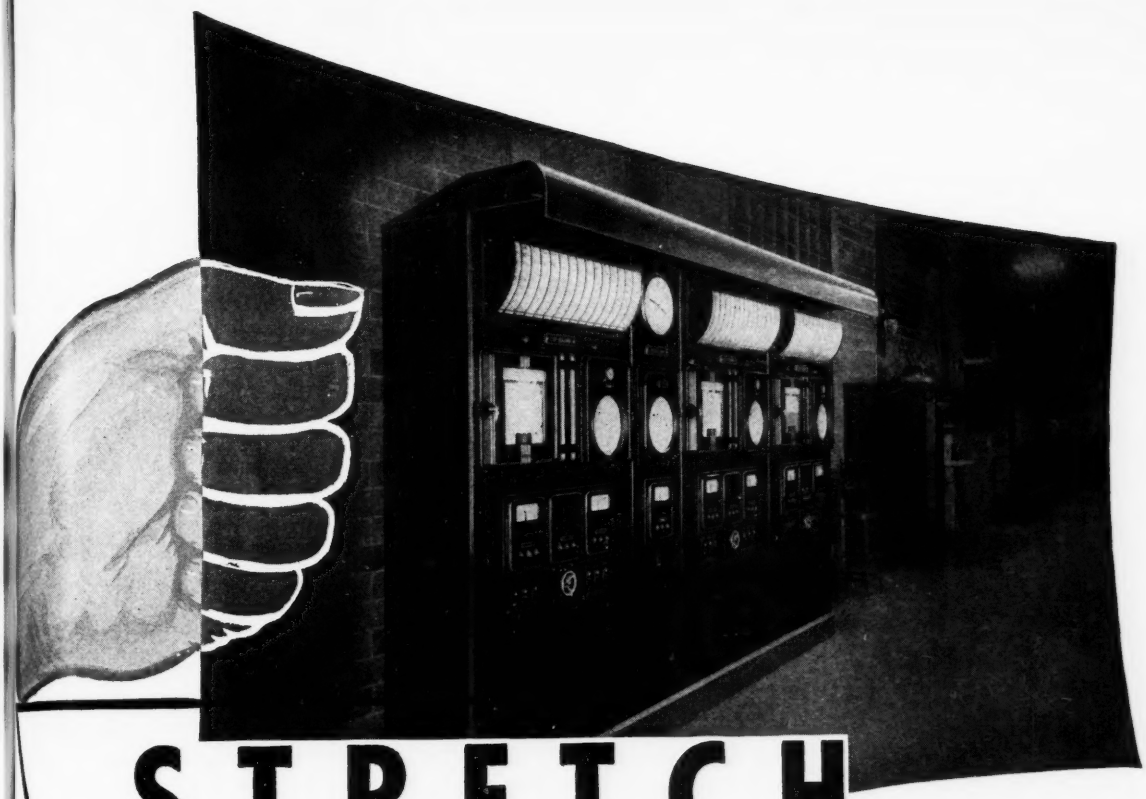
e = Extension or decrease in length (inches)

l = Original length (inches)

S = Unit stress produced—either tension or compression psi.

For a hoop and tube Eq. *1* can be reduced to

$$Sh = \frac{\Delta H}{d} \times E_h \text{ (for hoop)} \qquad (2)$$



STRETCH

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Sh = Tangential tensile stress in hoop.

ΔH = Increase in diameter of bore of hoop at nominal bore.

d = Nominal diameter or bore of hoop = 6.00″.

E_h = Modolus of elasticity for hoop—30,000,000 for steel.

$$Sc = \frac{\Delta T}{d_1} \times E_t \text{ (Tube)} \qquad (3)$$

Sc = Tangential compressive stress in tube.

ΔT = Reduction in outside diameter of tube.

d_1 = Bore of tube = 5.50″.

E_t = Modolus of elasticity of tube metal, Cast iron = 15,000,000.

$\Delta H + \Delta T$ = The shrinking allowance of hoop on tube. Assume it as 0.006″ or 0.001″ per inch dia.

Let X = decrease in diameter of tube, then

(0.006 — X) = increase in hoop bore.

To have stress evenly distributed *Eq. 2* must equal *Eq. 3*.

Then

$$\frac{30{,}000{,}000\ (0.006 - X)}{6} = \frac{X\ 15{,}000{,}000}{5.50}$$

whence X = 0.0039.

ΔT = 0.0039 for tube compression.

ΔH = 0.0021 for hoop bore increase.

$$Sh = \frac{0.0021 \times 30{,}000{,}000}{6}$$

$$= +\ 10{,}500 \text{ psi hoop.}$$

$$Sc = \frac{0.0039 \times 15{,}000{,}000}{5.50}$$

$$= -\ 10{,}600 \text{ psi tube.}$$

The long A. S. M.E. formula gives

Hoop = 10,600 psi.

Tube = — 9,800 psi.

From Trans. A. S. M. E. Vol. 59—1937. Design of Press & Shrink Fits. By Horger and Nelson. A-183. From line 1 Table 1—(A-184). Hub and Hollow Shaft of *Different Material.*

$$P = \frac{e}{\frac{1}{E_1}\left[\left(\frac{D^2 + d^2}{D^2 - d^2}\right) + M_1\right] + \frac{1}{E}\left[\left(\frac{d^2 + d_1^2}{d^2 - d_1^2}\right) - M\right]}$$

P = Unit pressure between hub and shaft (hoop and tube).

e = Unit fit allowance between hoop and tube per inch of nominal diameter—assume 0.001 per inch of nominal diameter.

D = Outside diameter of hoop = 6.50″.

d = Nominal common dimension of hoop and tube. Bore of hoop = outside diameter of tube = 6.00″.

d_1 = Diameter of bore of tube = 5.50″.

E_1 = Modulus of elasticity of hoop material. Steel = 30,000,000.

E = Modolus of elasticity of tube material. Cast iron = 15,000,000.

M_1 = Poisson's ratio for hoop material. Steel (Marks' M. E. Hand Book) .303.

M = Poisson's ratio for tube material. Cast iron (Marks' M. E. Hand Book) .270.

Solving for P

$$P = \frac{.001}{\frac{1}{30{,}000{,}000}\left[\left(\frac{6.5^2 + 6^2}{6.5^2 - 6^2}\right) + .303\right] + \frac{1}{15{,}000{,}000}\left[\left(\frac{6^2 + 5.5^2}{6^2 - 5.5^2}\right) - .270\right]}$$

$$P = \frac{1.000}{\frac{1}{30{,}000}\left[\left(\frac{78.25}{6.25}\right) + .303\right] + \frac{1}{15{,}000}\left[\left(\frac{66.25}{5.75}\right) - .270\right]}$$

$$P = \frac{1.}{.00118} = 850 \text{ psi (approximately)}$$

The coefficient of expansion for steel is given as 0.0000065 per degree F. difference in temperature.

Increase in the diameter of a circle can be obtained from the equation

$\Delta D = D \times \Delta T \times K$.

ΔD = Increase in diameter of circle.

D = Diameter of circle.

ΔT = The change in temperature deg. F.

K = Coefficient of expansion of metal.

Assume a temperature increase of 600 deg. F. which is a dull red.

$\Delta D = 6 \times 600 \times 0.0000065$.

ΔD = 0.0234 inches.

Note: Hoop should not be heated to a temperature that causes oxide to form on the inner wall.

The maximum tangential stress occurs at the bore of the hoop.

From Table 2—Page A-185, line 3, Tangential Stress at bore of hoop

$$= \left(\frac{D^2 + d^2}{D^2 - d^2}\right) \times P$$

$$\text{T. S. hoop} = \left(\frac{6.5^2 + 6.0^2}{6.5^2 - 6.0^2}\right) \times 850$$

$$= +\ 10{,}640 \text{ psi.}$$

The maximum tangential compressive stress occurs at the bore of the tube.

From Table 2—Page A-185, line 3 Tangential stress at bore of tube

$$= \frac{2 \times d^2}{(d^2 - d_1^2)} \times P$$

$$\text{T.C. Tube} = \frac{2 \times 6.00^2}{(6.0^2 - 5.50^2)} \times 850$$

$$= -\ 10{,}640 \text{ Comp.}$$

Summary of Stresses

Radial at outside dia. of hoop	0
bore of hoop	— 850
outside dia. of tube	— 850
bore of tube	0

Maximum tangential tensile stress is at bore of hoop = + 10,640 psi tension

Maximum tangential compressive stress is at bore of hoop = — 10,640 psi compression

It just happens for this particular problem the maximum tensile and compressive stresses are equal.

These values are well within the elastic limits of the respective materials.

Stresses for any other unit shrinking fit can be readily obtained. In the equation for P, the denominator is constant for a particular problem. Also the multipliers in equations for Ts and Ts remain constant. Values for e can be assumed and divided by the known denominator to obtain values of P. By trial, values of P can be obtained to keep Ts and Tc within the elastic limits.

San Francisco, Calif. CHARLES HUBBARD

Answer No. 221

Can He Connect 220-v Motor to Run on 110 v?

He can get 220-v. d. c. equipment, said C. W. W. in the April issue, but his power is at 110 v. How then, he asked, could he reconnect a 220-v. d. c. motor for use on 110 v. so it would run at its normal speed and horsepower?

Several readers answered this question but could give only the most general comments, since so little specific information was given with the question. Here are two of the comments.

Motor Must Be Reconnected or Rewound

THIS QUESTION cannot be answered directly. There are two ways of obtaining an answer as follows:

1. Communicate at once with the manufacturer, giving complete nameplate information as well as information about the proposed operating conditions. If the motor was built say within ten years and was one of a standard line, it is not unlikely that it can be reconnected with moderate expense for lower voltage operation. Unless the questioner has already done so, he can obtain better operation at the lower voltage even without reconnection by paralleling groups of field coils provided care is taken, in doing so, to keep the polarities correct.

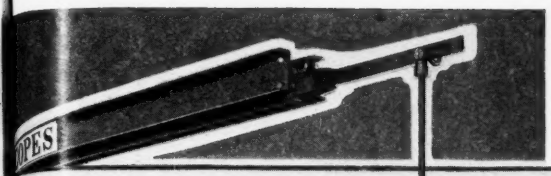
2. Any rewinding shop can do the work of reconnecting the armature and might do so cheaper and as satisfactorily as the motor manufacturer, provided of course that it is possible to do so.

Brooklyn, N. Y. C. O. VON DANNENBERG

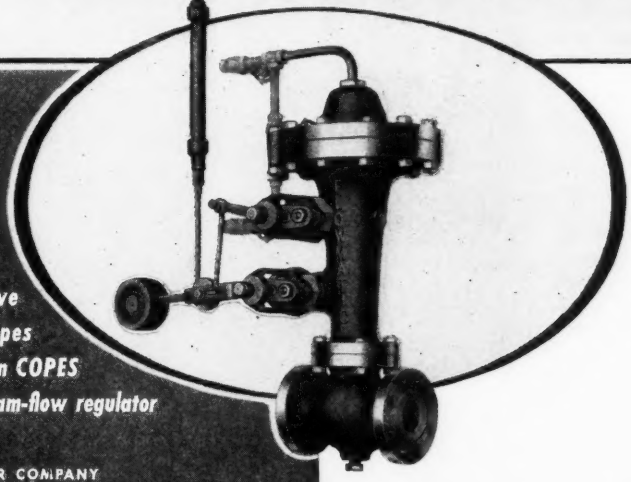
No—and Yes, Says Deichman

THE ANSWER is no, unless you have armature and field coils rewound and this will cost you a lot of money. You can cut a 220-v. motor down to 110 v. but you can step a 110-v. motor up to 220 v. by putting in a resistance coil or a rheostat.

New Orleans, La. GEORGE DEICHMANN



PAY ONLY FOR MODERNIZATION CONVERT TO FLOWMATIC



Just a few companies who have converted older Copes Regulators to modern COPES Flowmatic—the steam-flow regulator

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DETROIT EDISON COMPANY
EASTMAN KODAK COMPANY
GARDNER-RICHARDSON COMPANY
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JERSEY CENTRAL POWER & LIGHT COMPANY
JONES & LAUGHLIN STEEL COMPANY
NATIONAL CONTAINER CORPORATION
NEBRASKA POWER COMPANY
OTTER TAIL POWER COMPANY
PUBLIC SERVICE COMPANY OF COLORADO
PUBLIC SERVICE COMPANY OF NORTHERN ILLINOIS
PUBLIC SERVICE ELECTRIC & GAS COMPANY
REPUBLIC STEEL CORPORATION
SCOTT PAPER COMPANY
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YOUNGSTOWN SHEET & TUBE COMPANY
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SHELL OIL COMPANY, INC.

OVER 60,000 COPES FEED WATER REGULATORS IN SERVICE

THE cost of converting COPES Simple Level Regulators to Flowmatic, the 2-Element Regulator, has been kept to a minimum through sound basic design. As specialists in boiler feed water systems, it is our aim to make improvements readily adaptable to our thousands of COPES users.

The plants noted at the left are a few that have recently converted to Flowmatic—they paid only for the additional parts and service required.

The simple, sturdy, dependable COPES Regulator can either be made like new again or can be converted into a more modern type COPES unit. The scrap drive will never catch a COPES. If you are an old COPES user you will want to know how to convert to COPES Flowmatic. Write for booklet 429 that tells about Flowmatic, then we can talk about application or conversion.

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FEEDS BOILER ACCORDING TO STEAM FLOW-AUTOMATICALLY

Refrigerating System at Front Royal

Rayon manufacturing requires accurate control of temperatures, especially in the spinning processes. To supply refrigeration for cooling the liquids used in these processes, a refrigerating system of 750 ton capacity has been installed at the plant of American Viscose Corp. at Front Royal, Va. This article describes briefly the ammonia compressors and auxiliaries of the system

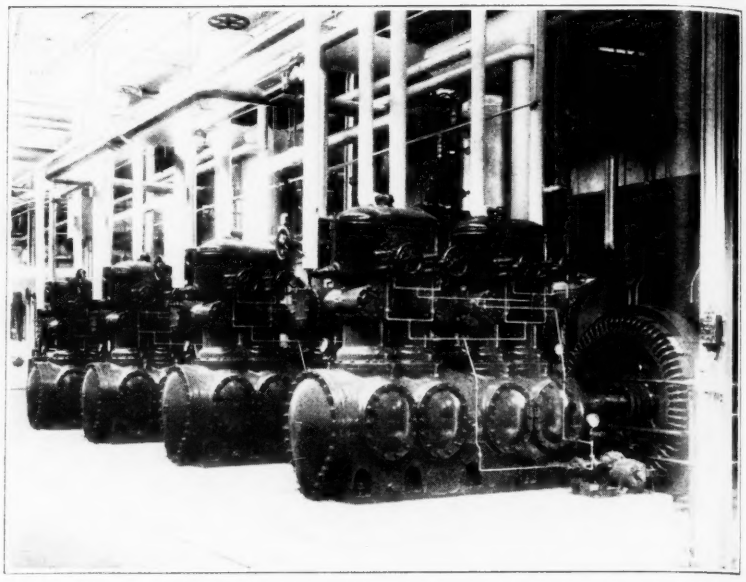


Fig. 1. View of four Front Royal ammonia compressors, with total capacity of 750 tons of refrigeration

LARGEST plant in the United States making viscose rayon is that of the American Viscose Corp. at Front Royal, Va. Opened only last year, this plant has every modern facility for large-scale continuous production; it operates day and night, seven days a week, making rayon staple fiber and the two viscose rayon yarns known as "Tenasco" and "Rayflex."

As is well known, the heart of the rayon process is the small thimble-shaped nozzle, pierced with tiny holes, called a spinneret. The streams of viscose, issuing under pressure from the holes in the spinneret, are immediately hardened by passing through a solution which coagulates the liquid. The filaments are then washed and bleached before being twisted into rayon yarn.

Accurate control of temperatures is a primary factor in production of high quality rayon. Most plants use cold water or cold brine as the refrigerating medium. At Front Royal, four large Frick ammonia compressors, two shell-and-tube brine coolers, with shell condensers, receivers, and complete auxiliary equipment, have lately been installed to take care of the increased capacity of the plant.

Each has four cylinders of 11 in. bore and 10 in. stroke. The cylinders are fitted with capacity controls, arranged to be opened either automatically by oil pressure, or by hand. The machines are driven at 360 rpm by 300-hp G.E. synchronous motors. Total capacity of the machines, under the specific operating conditions maintained, is 750 tons refrigeration. The capacity can be varied in steps from 100 to 25 per cent of full load, considering two machines as a unit.

The compressors discharge through ammonia oil separators into horizontal condensers, 42 in. in diameter by 15 ft long, above which the brine coolers are mounted, and below which is mounted the main liquid receiver, 36 in. diameter by 16 ft long. From this vessel the ammonia passes to a pair of smaller receivers in which the liquid is precooled on its way to the big brine coolers. These coolers each measure 60 in. diameter by 15 ft long and each contains 1100 tubes. A compressor of 4 in. by 4 in. size is connected to each of the liquid precoolers; these machines are also used for pump-out service. The system is charged with 11,000 lb of ammonia.

Auxiliaries include an automatic purger, two large float controls and float switches for the liquid feed, electric control valves, high- and low-pressure cutouts, six thermometers, two Tycos control panels, a tool cabinet, etc.

Another outstanding refrigeration installation by American Viscose Corp. is at its Parkersburg plant where a complete Frick plant is installed. This includes a 100-ton Freon-12 system, with two Eclipse compressors, one having six cylinders and the other four with shell-and-tube water coolers and condensers.

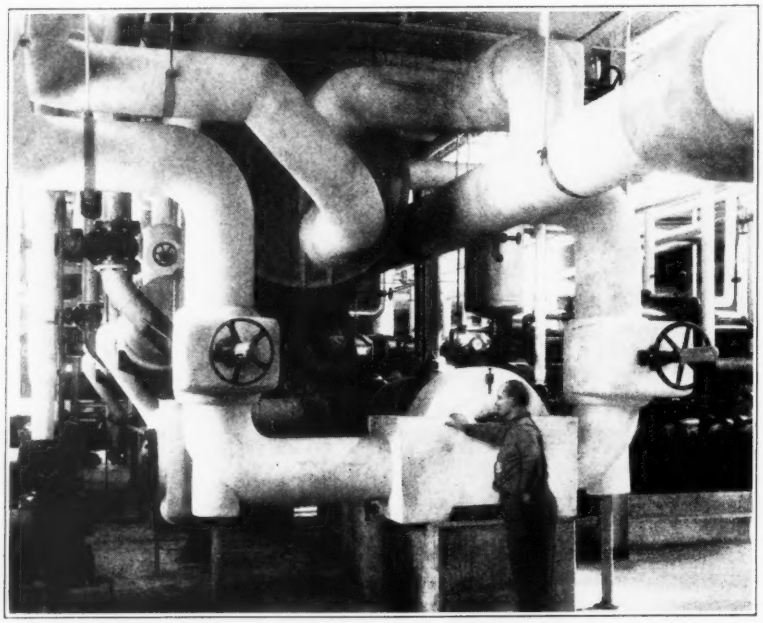
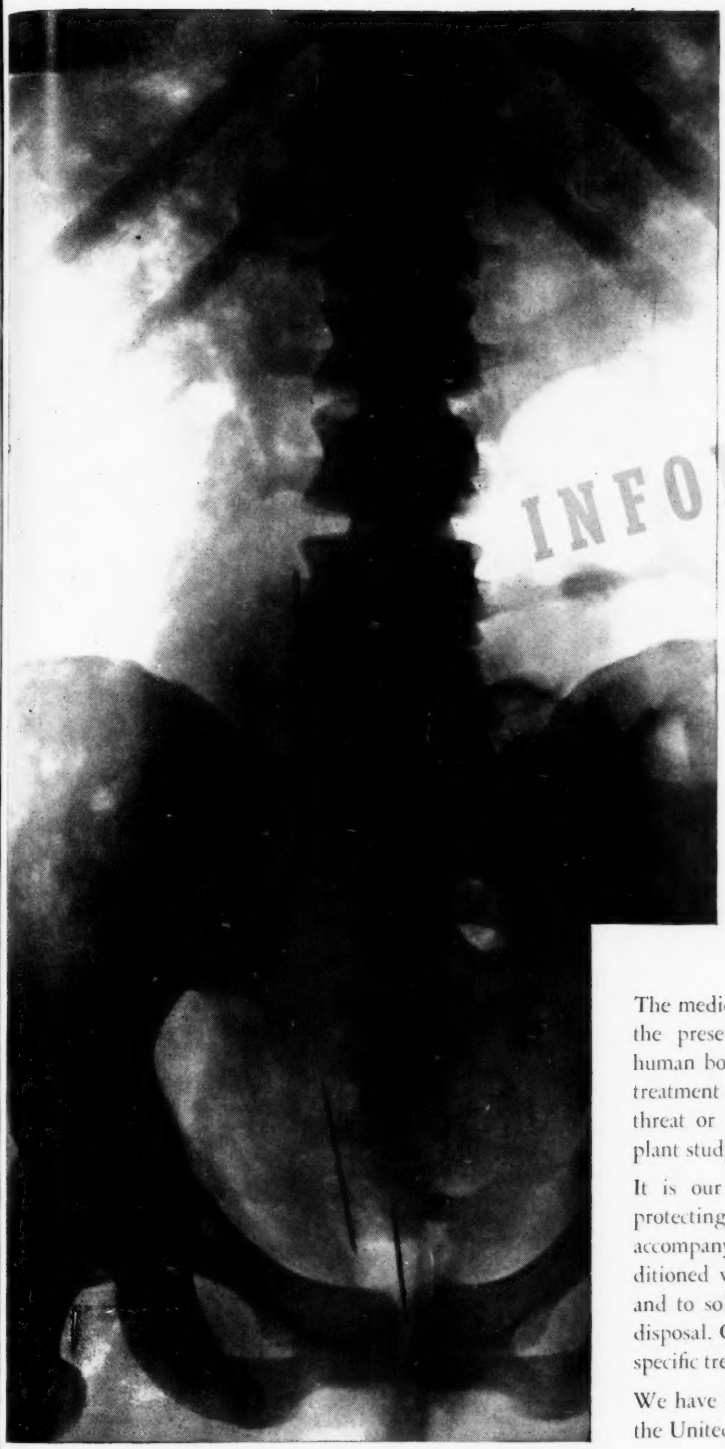


Fig. 2. This view, showing shell vessels and piping, demonstrates the large size of the Front Royal refrigeration equipment



The medical doctor can detect, by means of the X-Ray, the presence of a dangerous condition within the human body. Similarly, in the field of industrial water treatment the Betz organization can determine the threat or existence of a dangerous condition, through plant study and laboratory analyses.

It is our function to assume the responsibility for protecting industry from the many hazards which accompany the use of incorrectly or inadequately conditioned water for boiler, cooling, and process uses—and to solve problems of industrial waste and sewage disposal. Our service is complete for all industries, with specific treatment recommended for each individual case.

We have laboratories and engineers located throughout the United States and Canada.

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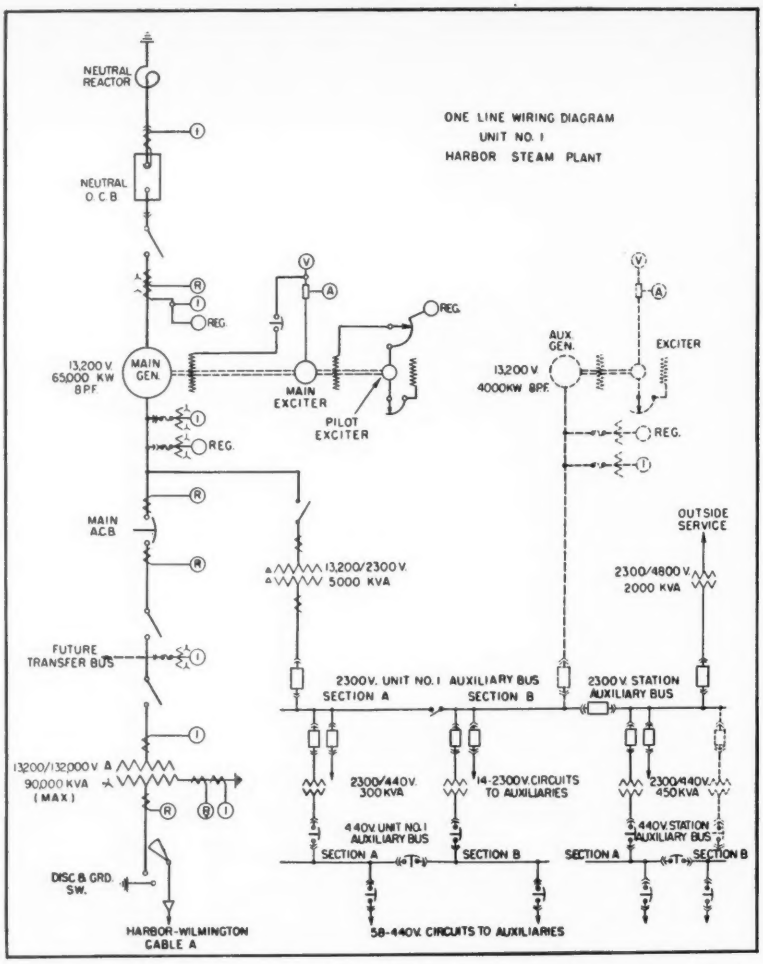


Fig. 7. One-line wiring diagram, Unit No. 1, Harbor Steam Plant, showing connection of main and auxiliary generators, main buses and transformers, and auxiliary buses

(*Continued from Page* 69)

the south; steam, generated in the boiler, continues northward to the turbine; and the electrical energy is delivered from the north side of the plant through the transformers to Receiving Station "C".

The building, of reinforced concrete supported by a structural steel frame, is designed, in accordance with local building code requirements for buildings of major importance, to withstand a horizontal seismic acceleration equal to 10 per cent of gravity acting on the building, combined with forces due to a horizontal acceleration of 20 per cent of gravity acting on the equipment. Because of the magnitude of the seismic forces involved and space requirements of the auxiliary equipment, an auxiliary bay was introduced between the turbine room and the boiler room to brace laterally the relatively flexible turbine-room and boiler-room framing. Figure 1 shows this arrangement.

The turbine room is provided with a 125-ton traveling crane to handle the heaviest part of the turbine or condenser, or the entire weight of one transformer.

The auxiliary bay is equipped with an automatic passenger elevator of 4000 lb capacity, which serves all floors from Elev. + 4 ft 6 in. to + 86 ft 0 in. The elevator is arranged so that the plant operator may take over its control in an emergency regardless of previously registered calls.

Railroad tracks enter the site from two directions, and trackage continues through the main turbine room so that the 125-ton crane can be used for unloading heavy equipment. A machine shop is provided at the rear of the plant to handle emergency repairs.

Automatic Control

For automatic control of water level in the main steam drum, the three-element control system equalizes the steam flow out of the boiler and the water flow into the boiler and corrects for water level in the main steam drum.

Amount of condensate pumped by booster pumps and condensate pumps is automatically controlled by the water level in the No. 3 heater storage tank.

Condensate level in the hot-wells is kept within desired limits by a make-up and draw-off system automatically controlled by floats in the hot-wells. Also an automatic control maintains the temperature of the condensate at not greater than 100 F and recirculation of the condensate at low loads, as described previously.

A minimum flow from the boiler feed pumps is maintained by automatically-controlled by-pass valves.

Rate of firing and steam pressure in the main steam drum are automatically regulated by one set of automatic control equipment. The automatic master control device corresponds primarily to a change in the rate of steam flow and secondarily to the resultant change in the steam pressure. Upon any change of steam flow and through the operation of the master control, the rate of fuel flow and the speed of the forced and induced draft fans is adjusted to maintain the correct operating conditions at all times. Following any operation of the master control, the fuel-air ratio and finally the speed of the forced draft fans are corrected to maintain the proper furnace pressure.

The automatic combustion control utilizes standard, pneumatically-actuated, fast-acting equipment and acts directly on the speed-control equipment of the fan drives.

Main Electrical Equipment

The total output of the Harbor Steam Plant will be transmitted directly to the 132-kv bus at Receiving Station "C", one of the Bureau's major receiving stations located about two miles north of the steam plant. At that point, power will be distributed into the 132-kv tie line system, or the local 34.5-kv distribution system, or both, as determined by operating requirements.

Since all of the electric energy from the plant will be transmitted directly to R. S. "C", the design of the electric facilities for the control and transmission of the power from the generator terminals to the 132-kv outgoing line is relatively simple, as shown in Fig. 7.

The ultimate design of Harbor Steam Plant anticipates several additional units. The basic de-

(*Continued on Page* 116)

NO. 6 OF A SERIES

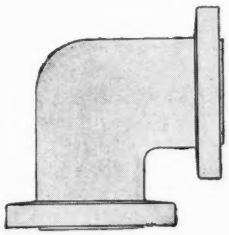
HOW TUBE-TURN WELDING FITTINGS LENGTHEN WAR INDUSTRY'S REACH

The FIRST WELDING FITTINGS AND STILL THE BEST

Weight saved* with Tube-Turn Welding Fittings aids war industry—by economizing steel, speeding pipe erection, conserving supports, reducing shipping weight.

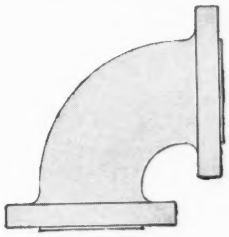
**Tube-Turn fittings in comparison below are 6", Schedule 80. Other fittings are 6", 600 lb. class.*

FORGED FLANGED ELBOW



450 lbs.

CAST STEEL FLANGED ELBOW

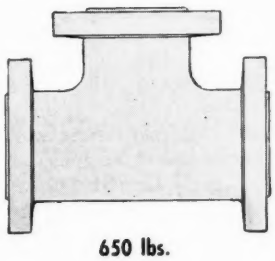


250 lbs.

TUBE-TURN WELDING ELBOW

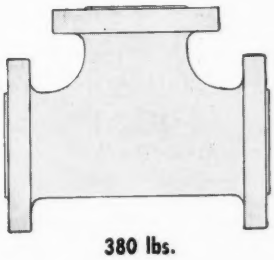
33½ lbs.

FORGED FLANGED TEE



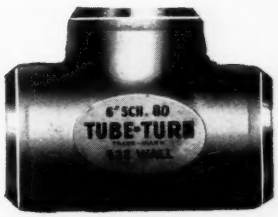
650 lbs.

CAST STEEL FLANGED TEE



380 lbs.

TUBE-TURN WELDING TEE



80 lbs.

THE examples illustrated above demonstrate the tremendous differences in weight between Tube-Turn welding fittings and other types of steel fittings. These comparisons are for 6" size (see note above), and other sizes are more or less proportionate.

Weight saving *always* has been an important reason for specifying Tube-Turn welding fittings. But today's war production needs stress additional advantages of this feature. It saves steel—because less of this strategic metal is required in making Tube-Turn fittings. Piping systems welded with Tube-Turn fittings are *lighter* and *streamlined*—which speeds erection, saves space, and simplifies structural problems. Remember these timely points when you buy or specify fittings for oil, gas, power, chemical, heating, air, refrigeration and marine piping today!

OTHER WAYS TUBE-TURN FITTINGS HELP WAR PRODUCTION:

SPEED INSTALLATION: Less time needed for aligning thanks to true circularity and uniform walls. Only simple butt welds required, easy even for novice welders. Whole section can be pre-assembled on the ground.

SAVES SPACE: Tube-Turn fittings permit streamlined, compact layouts and sharp angles—neater, more efficient piping.

REDUCES MAINTENANCE: No gaskets to replace, no nuts or bolts to tighten. Maintenance practically eliminated. Relieves men for other duties.

AVOID SHUT-DOWNS: Practically no danger of shut-downs due to connection failures as welding with Tube-Turn fittings *eliminates* the chances of leakage.

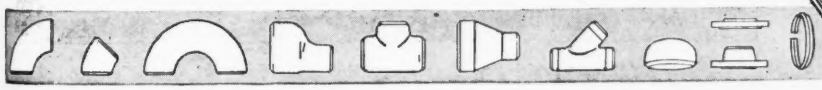
INCREASE SAFETY: Exclusive manufacturing process gives greatest possible strength in fittings, full freedom from leakage, and longer life in piping systems.

TUBE-TURN

TRADE MARK

Welding Fittings and Flanges

TUBE TURNS (Inc.) Louisville, Ky. ● *Branch offices:* New York, Chicago, Philadelphia, Pittsburgh, Cleveland, Dayton, Washington, D. C., Houston, Los Angeles. ● *Distributors in principal cities.*



ARMY E NAVY M

Winner of Army-Navy, Maritime Commission, Victory Fleet and Treasury Dept. flags.

(*Continued from Page* 114)
sign is for each generator to have an individual bank of transformers, the high voltage side of which will feed into a 132-kv system. Power is generated at 13,200 v, stepped up by the transformer bank to 132,000 v and then transmitted by paper-insulated, lead-sheathed, single-conductor, oil-filled underground cables to Receiving Station "C".

The generator is connected directly to the transformer bank through one 13.8-kv circuit breaker; one set of disconnecting switches built into the transformers isolates the transformer bank from the 132-kv cables and also serves to ground both the cables and the bank.

The 13.8-kv bus was designed to be totally enclosed and phase isolated by copper barriers but WPB requirements necessitated a change from copper to transite. The bus is arranged so that a transfer bus may be added in the future if necessary. The 13.8-kv generator circuit breaker is of the air-blast type with a rated interrupting capacity of 1,500,000 kva. It is housed in a steel cubicle which also contains the disconnecting switches for the bus feed to the main transformer bank, the disconnecting switches for the bus feed to the auxiliary-power transformer bank, the potential transformers and the necessary compressed-air facilities for operating the breaker. The air-blast type circuit breaker was selected because of space limitations, and to reduce the fire hazard of oil circuit breakers within buildings.

The main transformer bank has a rating of 67,500 kva self-cooled, 90,000 kva forced-air cooled, the latter rating sufficient to carry the maximum output of the generator at 0.8 power factor. In each transformer, a special compartment houses the 132-kv cable terminals, eliminating exposure of the high voltage parts to the weather. This arrangement was used because the Pacific on-shore winds deposit salt on exposed insulation, creating an electrical hazard and increased maintenance. The bank is connected delta on the low side and wye on the high side with a solidly grounded neutral.

Auxiliary Electrical Equipment

Local power supply for plant auxiliaries is provided by three sources: a 5000-kva transformer bank connected to the generator leads; a 4000-kw steam-driven house turbine-generator; and an independent power supply from the Bureau's distribution system.

As the steam plant develops and turbine-generator units are added, it is planned to have each main generator normally furnish its own power supply for its essential auxiliaries, with provision for transferring to another source. Local distribution within the plant is at 2,300 v, with three banks of 2300/440-v step-down transformers for the smaller auxiliary circuits.

All motors rated less than 100-hp operate at 440 v, while all larger ones operate at 2300 v.

The main 2300-v station service switchgear is located in the auxiliary bay. All feeder cables from this location to the various points of distribution throughout the plant are varnished cambric insulated with a Flamenol protecting sheath. The 2300-v switchgear is metal enclosed, equipped with removable truck-type oil circuit breakers. Each oil circuit breaker has rated interrupting capacity of 150,000 kva and was designed to meet the A.I.E.E. insulation and impulse requirements for breakers of 15,000-v classification. The total complement of units includes two 2000-amp main supply circuits, a bus tie breaker and seventeen 600-amp feeder circuits.

The main 440-v switchgear is also located in the auxiliary bay in a metal enclosed structure which houses the 440-v bus circuit breakers and cable terminals. The 440-v breakers are drawout-type air circuit breakers mounted on rollers, which permit their removal when the breaker is in the open position. The air circuit breakers have a rated interrupting capacity of 25,000 amp. Both the 2300-v and 440-v switchgear have sectionalizing switches in the center of the bus, with a source of supply feeding each bus section. The auxiliaries are distributed between the two respective bus sections, to permit maintenance without interruption of service.

Studies of all practical types of auxiliary drive indicated that electric motor drive should be employed wherever feasible because of the many advantages over other types. For simplicity of operation, freedom from trouble and minimum maintenance, the motors selected are single-speed, squirrel-cage, line-start, induction types designed for starting at 70 per cent voltage and guaranteed to carry full load for three minutes at this reduced voltage. Exceptions are the induced and forced draft fan drives previously discussed; the fuel-oil service pumps, one of which is driven by a constant-speed motor and one by a two-speed motor, to provide for this wide range in load; and the fuel-oil transfer pumps for transferring fuel oil from the storage tanks to the service tank, which are driven by two-speed, constant-horsepower motors to provide for variations in viscosity of the fuel oil.

Some of the auxiliary-drive motors are of the open-frame type, some the drip-proof type and some totally-enclosed, fan-cooled type, selection being determined by duty and location of the equipment.

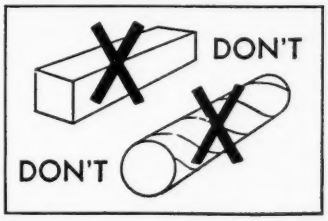
Control House

The plant is operated from a separate control house located 150 ft from the main building. In the control house are located the offi-

(*Continued on Page* 142)

Fig. 8. View of main station benchboard in control house, from which plant is operated

BURGESS SNUBBER BULLETIN on Diesel Exhaust Noise Control



HELPFUL HINTS

Never use flat-sided or thin-walled conduit for exhaust gases

The seemingly unimportant question of what kind of pipe to use to carry exhaust gases from the engine to the Snubber is really a big factor in quiet operation, in order to be sure that vibration and noise are not caused by the wrong kind of pipe. Where the wrong kind of pipe is used, the Snubber is sometimes blamed for noise which is really "pipe noise."

Flat-sided conduits, for example, should never be used. The sides of such rectangular pipes, even when they may seem heavy or rigid, vibrate like diaphragms in tune with the oscillation of the exhaust gases. Not only does this vibration cause "pipe noise," but it may become extreme enough to cause joints to open or the pipe itself to fail in service.

Spiral-welded pipe, or any other pipe which has thin walls, should never be used for exhaust pipe. Such a pipe will "talk" or "sing," causing a great deal of noise which can be completely avoided by using heavier pipe. Once exhaust gases pass through the Snubber, however, their flow is smoothed sufficiently so that any pipe of sufficient mechanical strength can be safely used for a tail pipe.

★ ★ ★

SNUBBING PROCESS THE SAME, WHETHER ENGINE HAS ONE CYLINDER OR EIGHT

Many engineers who clearly understand the exhaust action of a one-cylinder Diesel engine are not so clear in their own minds as to the nature of exhaust flow from a multi-cylinder engine. Basically, there is no difference between their exhaust actions, as can be seen by comparing the exhaust pressure fluctuations of both types.

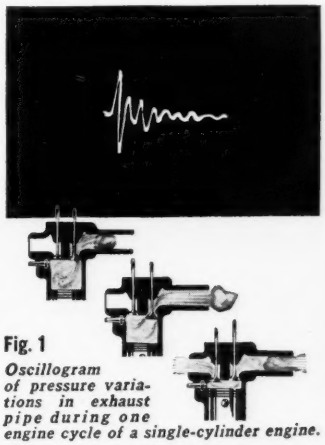


Fig. 1 *Oscillogram of pressure variations in exhaust pipe during one engine cycle of a single-cylinder engine.*

Figure 1 is an oscillogram of the exhaust pressure pulsations for one engine cycle of a one-cylinder engine. When the exhaust valve opens, there is an immediate surge in the exhaust line resulting in a high pressure peak, followed by an opposite reaction causing a negative pressure, and then a series of gradually smaller oscillations until the pressure approaches atmospheric just before the next exhaust impulse. This sequence recurs with each engine cycle and is the characteristic pressure pulsation of a single-cylinder exhaust.

The oscillogram in figure 2, covering one engine cycle of a four-cylinder engine, shows that the characteristic exhaust pressure pulsations occur as in figure 1, only four times as often for the same engine speed. Although the individual wave form varies from that of figure 1, the four individual exhaust impulses follow one another consecutively and each occupies only one-fourth of the complete engine cycle. There is no overlapping of these "slugs," and a snubbing action on this exhaust would be the same as on the one of figure 1. Had an eight-cylinder engine been used, running

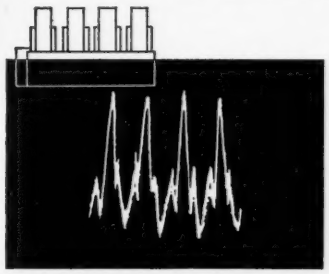


Fig. 2 *Oscillogram of pressures in exhaust pipe during one engine cycle of four-cylinder engine.*

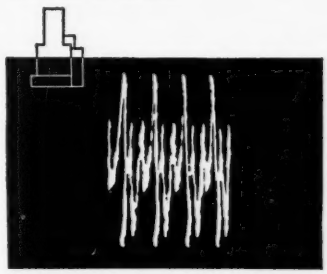


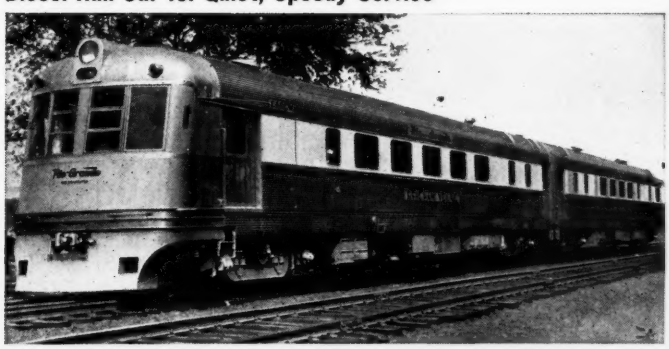
Fig. 3 *Oscillogram of pressures in exhaust pipe of one-cylinder engine at four times normal speed.*

at the same speed, eight of the characteristic pulsations would have occurred.

Figure 3 is taken from the exhaust line of the one-cylinder engine operated at four times normal speed. Here again, four characteristic exhaust pressure pulsations occur. Operating this engine at eight times normal speed would have resulted in eight characteristic pressure pulsations, comparable to those of an eight-cylinder engine.

In any multi-cylinder engine, this same similarity exists; i. e., the only difference between a one-cylinder and a multi-cylinder engine exhaust is the frequency with which the characteristic exhaust pressure pulsations occur. In either type, the Snubber smooths the pulsations and consequently eliminates the noise caused by them.

Diesel Rail Car for Quiet, Speedy Service



The two-car train shown above is one of many such combinations now used by the railroads for short line service. This one, with its twin—both called "Prospectors"—is in regular service on the Denver and Rio Grande Western Railroad. It is powered by four flat-type Hercules Diesel engines, two under each car. There's no exhaust noise to bother passengers, because each engine is equipped with a Burgess Exhaust Snubber to assure quiet exhausts without interference with efficient engine operation.

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TRENDS IN THE USE OF NEW EQUIPMENT

(*Continued from page 75*)

and circuit reclosing. Transmission lines are now made lightning proof through application of shielding theory developed in the laboratory. Practically all new high voltage lines are now provided with shielding wires. Protector tubes are being applied on existing unshielded lines and on new voltage lines where shielding would be uneconomical. Lightning arrester applications are made with more accuracy, and apparatus insulation levels have been established that definitely fix the lower limits of surge strength. Simplified methods have been devised for determining system fault currents, and a better knowledge of lightning characteristics, gained from extensive field investigations, has resulted in arresters with improved protective characteristics and more adequate discharge capacity. Therefore, it is now possible to assure a high degree of protection to station apparatus with little likelihood of arrester failure.

Single circuit lines that are subject to lightning flashovers are made more useful by providing high speed fault clearing and high speed reclosing circuit breakers. Ground fault neutralizers, although not effective for faults between phases, are successfully used where applicable to prevent outages due to line to ground faults. The pneumatically operated circuit breaker has been developed to meet the need for ultra high speed reclosing. This type of mechanism provides the high operating force necessary for fast reclosing without a high momentary demand upon station service power.

A single pole tripping and reclosing installation is now operating on an important 132 kv tie circuit. Field tests indicate that this will prove to be another effective tool for increasing the usefulness of single circuit lines. Single pole fault clearing and reclosing of long outlying distribution circuits has become more common. Fuses have been used with a fair amount of success for this purpose, but in many cases there is need for a device that is self-restoring after a successful reclosure, with a time delay before reclosure and a definite time-current characteristic independent of previous heating. A new oil filled porcelain clad single pole recloser which fulfills these requirements has recently been developed. The device receives its opening energy from a series coil and is spring closed, and as a result is entirely self-contained, including lightning protection. By proper choice and connection of the series coil it is possible to obtain accurate selectivity with fuses or with other breakers on an extended distribution system.

System Control

The increased complexity of system interconnections and the heavier loading of tie lines and apparatus have presented many operating problems. Outstanding among these are control of load division in loop circuits, control of power between systems, and system stability. Therefore, we see more applications of phase angle and voltage regulating transformers for power flow control. Extended telemetering and remote control schemes are required to measure and control system interchange of power. Stability limitations have demanded more from relaying and circuit breaker equipment. Carrier current and direct wire pilot relaying have proven to be the best solution to the relaying problem. The relay engineer now recognizes and accepts carrier relaying as the most effective means of providing reliable high speed fault clearing on interconnected circuits. Fast fault clearing requires, in addition to high speed relays, circuit breakers having short interrupting time. High voltage oil insulated circuit breakers that have an interrupting time of three cycles are now in service. A few experimental installations of outdoor high voltage compressed air breakers are being made.

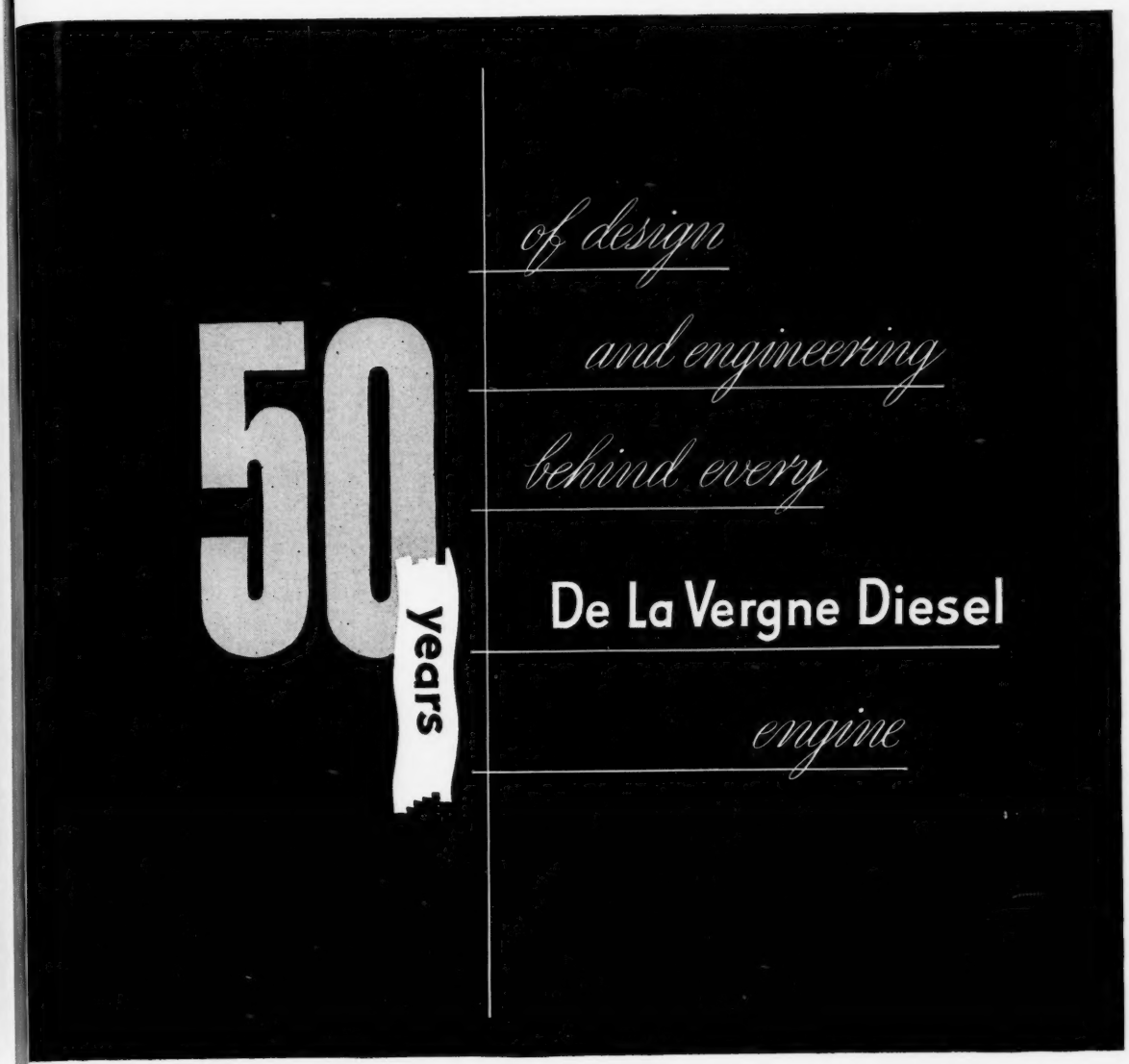
The demand for substation equipment that can be quickly and easily installed, moved, or expanded has created a decided trend toward factory built unit substations. Such units, which formerly found their chief application in primary networks, are now used extensively in both primary network and radial systems. The self-protected single circuit power transformer unit substation has become popular for applications where only a single secondary breaker is required.

Extended Use of Unit Substations

The unit substation idea has been extended to low voltage equipment. Thirteen standard switchgear units are now available adaptable to almost any combination of switching and metering with from 15,000 amp to 100,000 amp interrupting capacity at 600 v. The desired switching apparatus is connected to the transformer through a throat attachment to give a complete low voltage indoor power center unit. For motor loads, there has been developed a standardized, low voltage control center, which is proving popular because of its flexibility and ease of installation. Individual motor control elements are mounted on small panels of uniform width and depth, and they are stacked one above the other to form a completely assembled control board either 76 or 90 in. high. The number of panels in a stack can be varied from two to five, depending on the starter size.

The difficulty of obtaining new equipment has emphasized the suitability of the portable substation for standby and emergency service. New high permeability magnetic sheet steel and forced oil cooling have made it possible to put on wheels transformers of 6000 kva capacity or more together with the necessary switching and protective equipment, without exceeding highway limitations.

While residential distribution has had to stand aside somewhat to make way for additions to industrial power facilities, we do find a great amount of attention being given to industrial distribution. The secondary network, at present used in 164 cities, has also found a place in industrial plants and generating stations of today. The secondary network fulfills the requirements for a reliable power supply in these plants where because of high load densities, voltage regulation is a problem, and where outages from secondary faults caused by accident or sabotage must be avoided. The plant network is usually fed from two power feeders, with a double throw switch to permit connection of the transformer to either feeder. Normally, each feeder carries half of the network units. In case of a feeder outage, the units connected to the good feeder will carry the load until the faulted feeder can be put back in service, or until the idle network units can be switched to the good feeder. The secondary system usually takes the form of a loop made up of two conductors per phase between load buses. Each end of each conductor is provided with a limiter to isolate the conductor in the event a fault occurs. Limiters are available in interrupting ratings up to 50,000 amp at 600 v. They are normally mounted



In 1893, De La Vergne built its first oil engine, which today is considered by many to be the forerunner of the modern diesel engine. Starting with the oil engine, every De La Vergne that has followed has been engineered and designed to meet the exacting requirements of the application.

De La Vergne has built diesel engines for practically every type of application. Ranging from 200 bhp to 1,600 bhp, they have provided unfailing low cost power in ice plants, marine and diesel-electric locomotive installations, industrial plants, textile, cotton oil, and flour mills, public buildings, hotels, colleges and others.

The knowledge and experience gained in 50 years of oil engine manufacturing is built into every De La Vergne.

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in the load bus structure along with load-break switches for isolating the limiters for repair or maintenance. The load bus unit also includes the necessary air breakers for the short radial load circuits. All the necessary network equipment is thus included in two compact units, the network unit and the load bus unit. The new completely air-cooled network unit, including the transformer, protector, and primary selector switch, fulfills the fireproof requirement so important in war plants.

The secondary network is particularly applicable to plants having two or more primary feeders for power supply, a peak load above 1000 kva, and a load density of from 10 to 15 va per sq ft of floor space. In a plant of this size, the installed cost of the secondary network is about 15 per cent higher than the cheapest form of radial system and is up to 15 per cent lower in cost than the more elaborate forms of radial systems now in use in some industrial plants. Requirements for continuity of service may justify its use in smaller plants even though its initial cost may be higher.

Operation at Higher Loadings

Increased loads and the difficulty of obtaining new equipment have made it necessary to load apparatus and feeder circuits to their limits. Loading by temperature, which has been employed on self protecting distribution transformers for a number of years, is now extensively used on large transformers. A thermal relay actuated by oil temperature and by load current is calibrated to follow closely the heating characteristics of the transformer. It will permit the transformer to carry its maximum safe overload for the maximum permissible time.

Power factor correction has for some time been recognized as an economical means of getting more kilowatts out of apparatus and feeder circuits. Therefore it is natural that it is being used more extensively at the present time. Developments in shunt capacitor design have brought the installed cost down to approximately eight dollars per kva. Because of this the use of shunt capacitors has doubled in the last two years. Frequently shunt capacitors are installed in large banks with automatic switching equipment, arranged to cut sections of the bank in and out as required. A small compact 180 kva automatic capacitor unit also is available. One or more of these units can be operated in a group, and additional units can be added as required, with the control set to give selective tripping between units. Standard hanger type units have become especially popular for distribution feeder circuits. Several of these may be inconspicuously pole mounted at one location, or they may be distributed along the line as desired.

The outdoor synchronous condenser has frequently been used for substations handling very large blocks of power, and in moderate-sized installations the cooling air is cleaned by Precipitrons; thus open air cooling is made possible without danger of injury to the machine windings.

Regulators are usually required on heavily loaded feeder circuits and are used either independently or in conjunction with shunt capacitors. This is particularly true if the load varies considerably. The relative effectiveness of shunt capacitors and feeder regulators will depend upon the power factor of the load and the characteristics of the circuit. If the power factor is high, or if the ratio of resistance to reactance of the line is high, a regulator will usually be required.

Reducing Voltage Fluctuations

There has been a marked increase since the war started in the number of welding and furnace loads which require correction against voltage fluctuations, and several schemes of correction or compensation are available. Sometimes separate feeders are used to feed large fluctuating loads, and frequently where the fluctuating load is of sufficient magnitude to cause voltage variation at the substation supplying the feeder a flicker bus is provided to isolate the fluctuating load from the regular load bus. The flicker load may also be isolated by means of a flywheel M-G set. Still another scheme is to absorb the fluctuations with a synchronous condenser connected to the substation bus. The latter scheme can be made more effective by connecting the synchronous condenser to the bus through a reactor, with the fluctuating load connected between the condenser and reactor.

The series capacitor has proved effective in correcting for fluctuating loads of moderate magnitude where lighting load is carried by the same feeder. Protection of series capacitors from excessive overload and short circuits has been greatly simplified through the development of a small vacuum gap. This gap, which is enclosed in solder-sealed porcelain, is remarkably consistent in breakdown and will stand repeated operation. It can be mounted in a cabinet along with the necessary contactor and high voltage bushing, making the entire unit only slightly larger than a standard capacitor unit. Series capacitors should be applied only after making a thorough analysis of the circuit and load conditions. They must be properly located in the circuit, and the possibility that they may cause surges in the line under certain conditions involving self-excitation of motors and transformer magnetizing inrush currents, must be investigated.[1]

War requirements have made it necessary to conserve materials and in many cases substitutions are necessary. Alternative materials sometimes prove better than the original product. As an example, the shortage of aluminum made it necessary to develop a substitute for street-light hoods, and a silvered glass reflector that has many advantages over the original aluminum hood, was designed. The new hood has a cut off angle of 75 deg compared to 70 deg for the old one, and its high reflection factor is easily maintained by a simple cleaning process. There are many similar cases where war conditions have led to the development of new and superior substitutes. One of the outstanding examples of material conservation involves the development of Hipersil transformer iron. By using Hipersil it is possible to reduce the size of distribution transformers approximately 25 per cent without sacrificing regulation and overload capacity. Hipersil power transformers with forced oil cooling systems, completely assembled with bushings, are available in sizes up to 40,000 kva at 132 kv. The use of air cooling where suitable eliminates the need for insulating oil, saves vital material and at the same time materially reduces the fire hazard.

It can be seen that the war program has brought about many important developments in materials and design and has created many new and difficult applications. By successfully solving these problems, engineers are doing their bit to hasten the final day of victory.

[1]Editor's Note: Recently a portable welding unit embodying a storage battery has made its appearance. This interposition of a storage battery between the line and the welding arc, almost completely eliminates voltage fluctuations.

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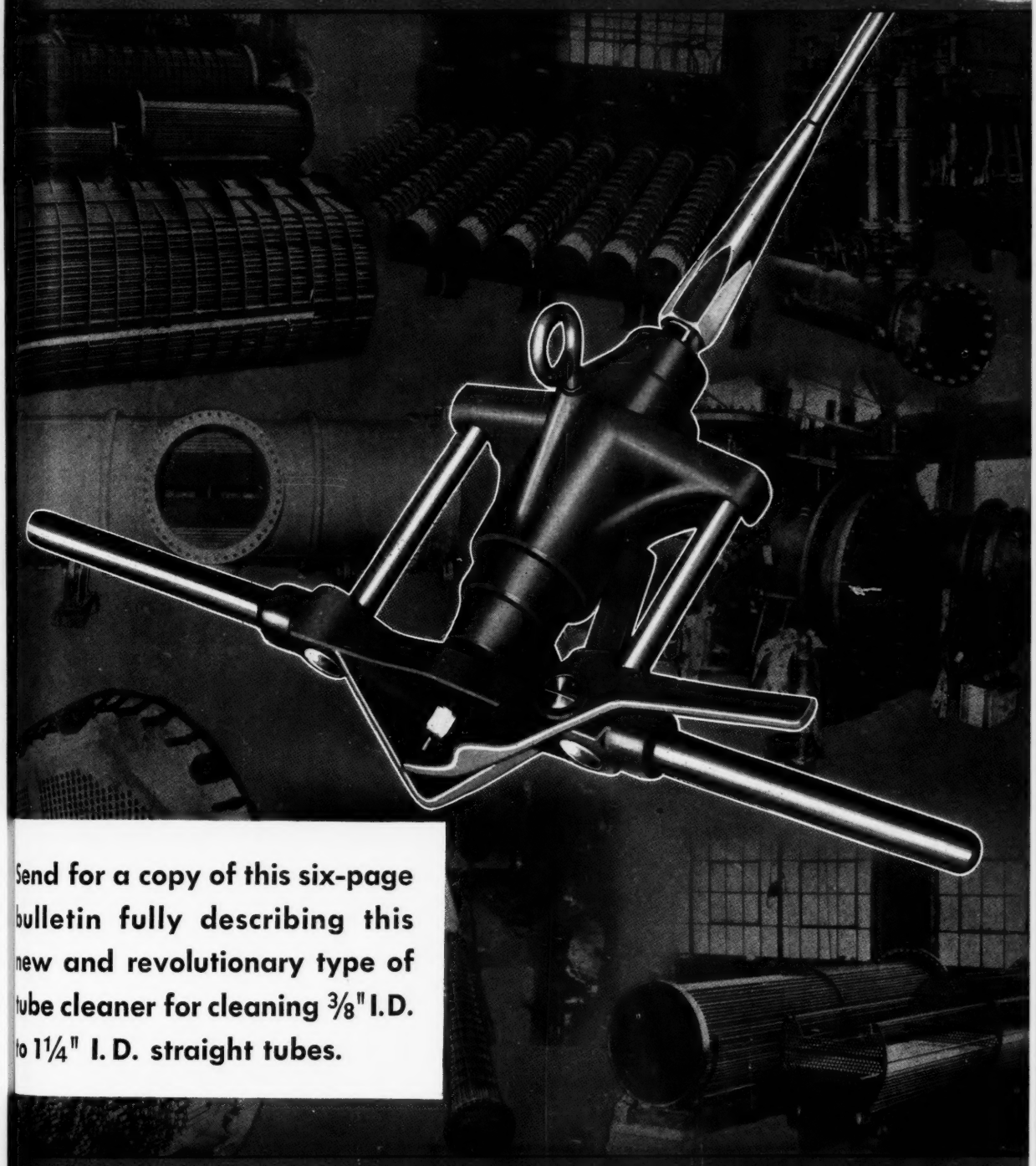

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ASME SPRING MEETING

(*Continued from page* 88)

a chain of difficulties any one of which may cause a shutdown.

Chemical Removal of Scale

"In spite of the methods employed to reduce carryover from boilers, both water-soluble and insoluble turbine deposits are prevalent," said W. L. Webb and R. G. Call of the American Gas and Electric Service Corp. in their paper on the removal of turbine blade deposits. Where these deposits are water insoluble, disassembly of the turbine with resultant capacity outage has been necessary. For the removal of water-insoluble silica deposits, a caustic-soda-solution washing procedure has resulted in regaining lost capacity and in restoring stage-pressure differentials to normal in a fraction of the time formerly required for removing deposits mechanically from buckets and diaphragm nozzles. This has been accomplished by using available connections as injection points and without definite knowledge of conditions for most complete removal of deposits.

Topping units, or any high-pressure condensing units, it is believed, can be successfully washed, provided (1) facilities can be made available for introduction of the caustic solution at suitable points; (2) temperatures can be properly controlled; (3) wash water can be injected where it will remove soluble deposits and residual caustic effectively; and (4) the washings can be run to waste.

Removal of scale from various commercial units, such as boilers and other heat-exchange equipment, with inhibited hydrochloric-acid-base solvents is comparatively new. In the method described by Alquist, Groom and Williams, a sample of the scale to be removed is subjected to X-ray and spectroscopic analysis and solubility tests as an aid in determining the conditions of treatment.

Cooling-Tower Problems Solved Graphically

Need for standardization in cooling-tower practice and the adoption of a common basic theory for correlation of the vast amount of experimental data, coupled with practical experience now available, was stressed by Joseph Lichtenstein in his paper on the performance and selection of mechanical draft cooling towers. Such a theory would be invaluable in calculating performance at the guarantee point from test data taken under other conditions of service. From Merkel's differential equation for the cooling tower, the author derived a basic dimensionless equation for calculating cooling-tower performance. A graphic method of solution of the basic equation was shown which, in the form of curves, allows quick and exact answers to all cooling-tower problems. The adoption of the basic equation by the cooling industry was urged so that a common method of correlation of tests as well as a common method of translation of performance from one set of conditions to another may be available to the industry.

Coal Storage Session

Due to the country-wide campaign conducted last year to induce users of coal to store larger than usual quantities of coal at the point of use in order to relieve the mines of peak production problems, take some of the burden off transportation systems during the winter season and to insure users a sufficient supply to see them over periods when deliveries could not be made promptly, the panel discussion on coal storage brought out many problems and solutions helpful to users. This session was conducted under the chairmanship of G. C. Daniels with H. C. Carrol as recorder. The speakers included R. J. Brandon of the Detroit Edison Co., John M. Drabelle of the Iowa Electric Light & Power Co., W. D. Langtry of the Commercial Testing & Engineering Co., Carl J. Eckhardt of the University of Texas, T. C. Cheasley of the Sinclair Coal Co. and V. G. Leach of Peabody Coal Co.

This session developed into a discussion of methods and means of storing coals under present day conditions with emphasis on experiences of the past year.

The directions for storing coal as brought out by speakers may be summarized as follows:

Select storage area that requires least transportation of fuel, is well drained and not subject to flooding.

Prepare bed by removing all debris and scraping ground to get rid of shrub and grass roots. A layer of crushed rock is sometimes recommended.

Any kind or size of coal can be successfully stored if not segregated.

Spread coal in layers with bulldozer or similar equipment, to prevent segregation of sizes, and compact with caterpillar tractor, roller or truck wheels. Some recommend that each layer be rounded so as to drain. Compacted coal should occupy about 15 to 20 per cent less space than loose pile. Pile so that no air currents or chimneys can be created through coal. Flat top piles are preferred. Prevailing winds should blow across piles. A convenient size pile is 100 ft by 50 ft by 8 ft. All foreign materials should be kept out of pile; don't pile around posts.

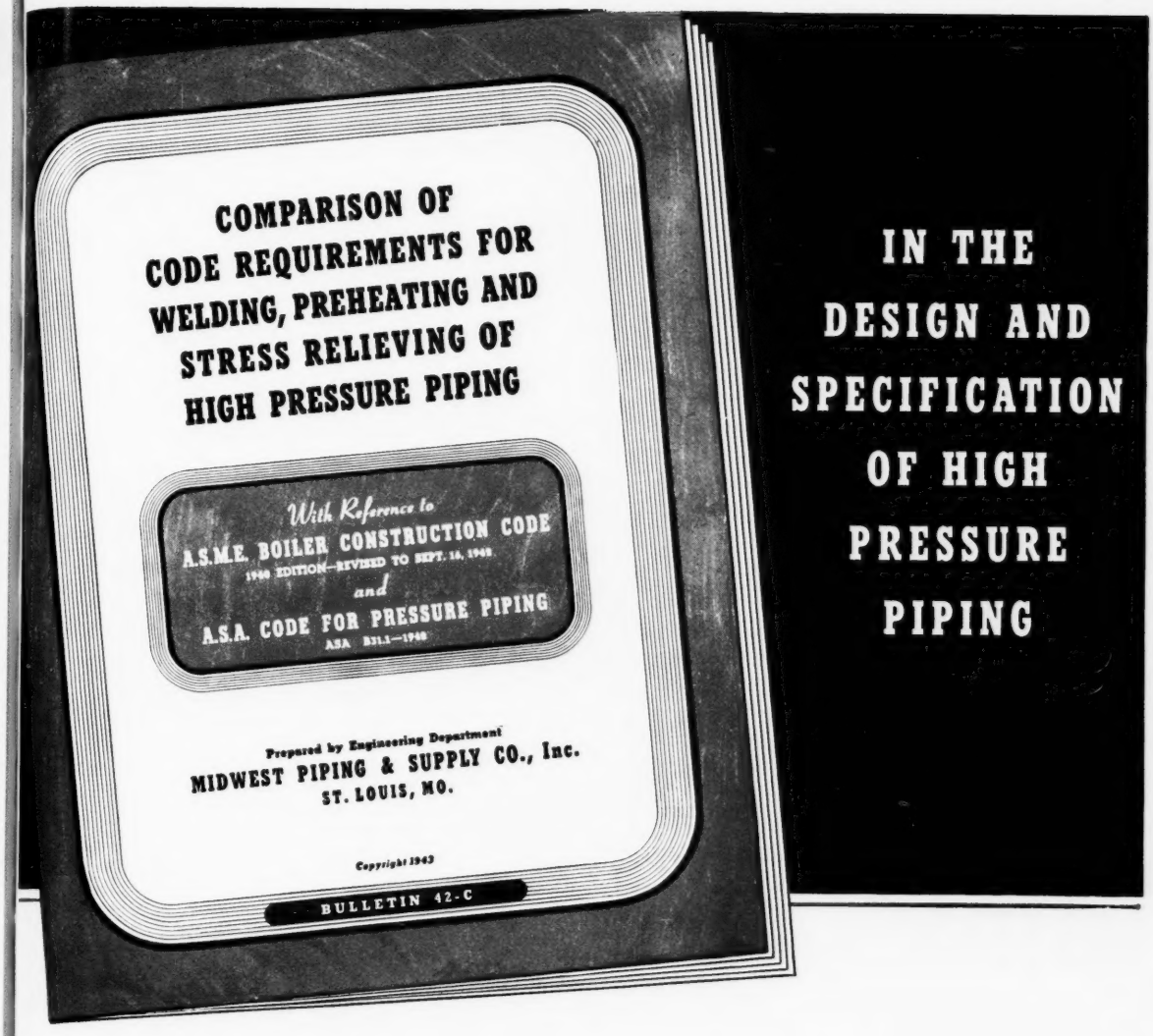
Inspect pile frequently, particularly immediately after piling, and in spring and fall. Dig out and use or cool the coal from spots where temperature reaches 150 F. Reclaim from end of pile.

"The long range built into the Fortress and Liberator has saved the day in the Pacific over and over again.

"The Italian planes have fought only in the Mediterranean area, the Germans in Europe and Africa, the Japs in China and the Pacific, while American planes are fighting in Alaska and Iceland, Tunisia, and New Guinea, over China, Russia and Germany.

"An absolute comparison of one airplane with another, without regard for its designed purpose and particular combination of qualities (and compromises) the designer had in mind, is unfair. The box score of battle results is on the whole a good indication of the quality of military airplanes, but that, too, may be affected by the skill or even the philosophy of the pilots, and the combat conditions. On the basis of the box score the American record, both Army and Navy, for 1942, showed an average in each service of about four enemy planes shot down to one of ours lost. This is a better showing than any other air force in the war to date.

"Another yardstick which appears to be more theoretical but actually may be more accurate for an absolute comparison, plane for plane, is a "combat efficiency" rating based on factors in the performance of military aircraft, properly weighted as between fighters and bombers. For example, in a fighter, climb and maneuverability will rate higher than in a bomber, whereas range will be lower. Some of the performance factors are: speed, climb, ceiling, firepower, armor, maneuverability, bomb load, defense, range, ease of production and maintenance."—Lt. Col. Nathaniel F. Silsbee.



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We shall be glad to send a copy to anyone interested who will write the nearest Midwest office on his company letterhead. There is no obligation. Ask for Bulletin 42-C.

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Ships, high octane gasoline, materials for synthetic rubber, handling and transfer of gasoline by Army and Navy, will absorb valve production for some time.

To say we wish this were not so is just another way to say we pray for early victory. You will back us up in our belief that the best way for us to help bring this day closer is to continue to do all we can to deliver to every agency of war the valves requisitioned of us.

In the meantime, continue to guard your valves by regular inspection. It will point the need for maintenance that will make them last longer, give more satisfactory service.

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Anti-Corrode, Proved Perfect by Months of Laboratory Testing, Meets Severest Corrosion Requirements. It's Easy, Economical to Apply.

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METHODS OF APPLICATION

Anti-Corrode can be applied to raw stocks, finished parts, or to complete machines during storage, assembling or shipping. It is easily applied by dipping, brushing, rubbing, hand or power spraying—and provides a safe film which does not harden, become brittle or crack.

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Anti-Corrode has no disagreeable odor.

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Anti-Corrode is chemically inert to ferrous or non-ferrous metals. Therefore, it can cause no injury to any metal to which it is applied or with which it may be brought in contact.

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Surfaces coated with Anti-Corrode can be handled freely without danger of rust spots caused by hand acid.

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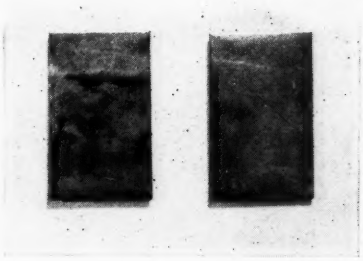

BOTH STRIPS of freshly ground steel pictured here were immersed for 20 hours in a 3% salt solution. Strip on left was untreated; strip on right, coated with Anti-Corrode, shows no trace of rust. (Even after 90 hours of immersion Anti-Corrode coating still resisted rust.)

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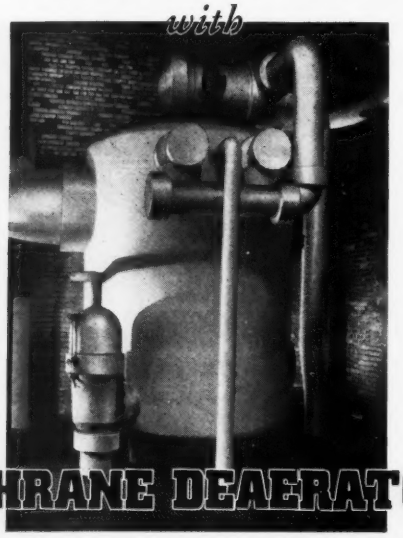

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before it starts!

INCORRECT GASKET and Packing permits Leakage and Corrosion . . . Studs are weakened . . . Spindle damaged

Because the wrong type of gasket was used on this Iron Body Y Valve, leakage developed at the bonnet-flange joint. Concentrated at the bottom half of the flange, the leakage seeped through the stud holes in the bonnet. The resulting corrosion so weakened the studs (1 and 2) that tightening the nuts to overcome the leakage would eventually have twisted them off. The difficult repair job of replacing these studs would require a complete shut-down of the boilers feeding the line in which the valve was installed, with a resulting interruption in plant production.

In the valve illustrated, a full face gasket was used for the bonnet joint, which was too soft and too thick for the service. A thinner, 1/16" thick ring gasket of good asbestos sheet packing material would have kept the joint steam tight and prevented destructive corrosion.

A ring asbestos gasket is generally recommended for Iron Body and Steel Valves used in moderately high pressure services, up to about 500 lbs. Full face gaskets are suitable for some lower pressure services, and for use with Bronze Valves.

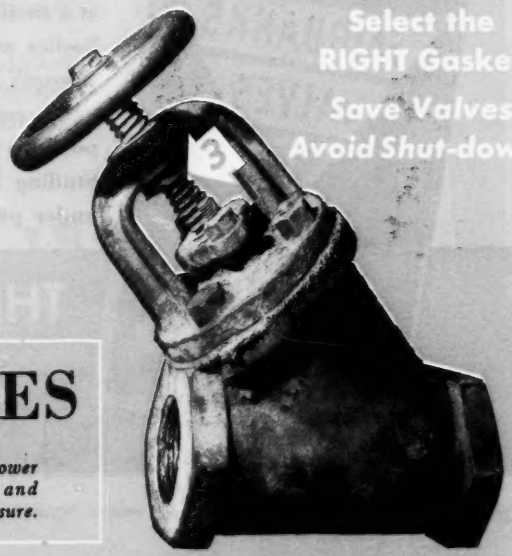
Thin gaskets are less likely to develop leaks than thick. When soft packing is installed, follow up the bolts, tightening them again after the line has been in service for some time.

Corrosion has also attacked the spindle of the valve (3), below, because faulty packing allowed leakage at the packing box. This is another example of destruction that could be easily avoided by proper inspection and conservation measures.

Stop such waste of critical metals. Prevent loss of production through valve failures. Make sure your valves are inspected regularly, systematically. Repair or replace worn parts before a valve destroys itself. Instruct maintenance workers thoroughly and supply them with the necessary parts and tools. Select valves for new installations carefully; install them properly.

Jenkins Engineers will provide any assistance you need for improving your system of valve conservation.

Jenkins Bros., 80 White Street, New York, N. Y.; Bridgeport; Atlanta; Boston; Philadelphia; Chicago. Jenkins Bros., Ltd., Montreal; London.



Select the RIGHT Gasket

Save Valves

Avoid Shut-downs

JENKINS VALVES

SINCE 1864

For every industrial, engineering, marine and power plant service . . . in Bronze, Iron, Cast Steel and Corrosion-Resisting Alloys . . . 125 to 600 lbs. pressure.

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YOU CAN BANK ON FAIRBANKS

for RENEWABLE Iron Globe, Angle and Cross Valves

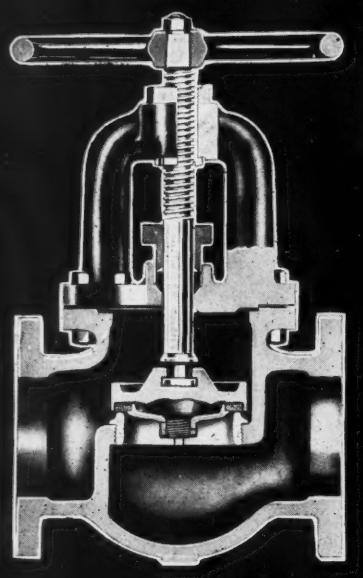


Fig. 0102

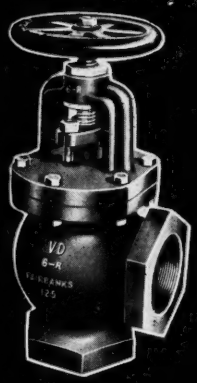


Fig. 0103

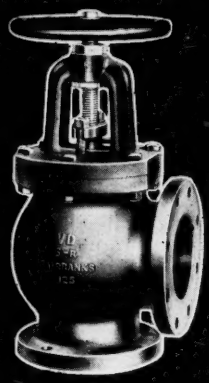


Fig. 0104

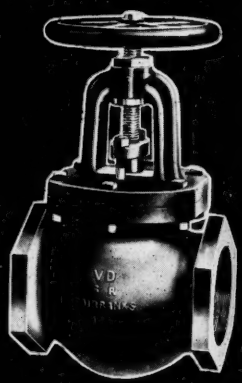
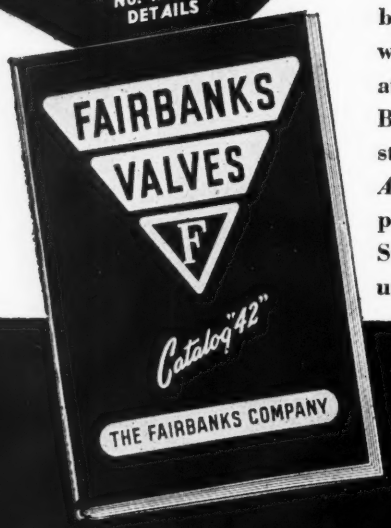


Fig. 0101

OTHER FAIRBANKS VALVES

Bronze Globe, Gate, Angle Cross and Check Valves
Iron Globe, Gate, Angle, Cross and Check Valves
Faircoseal Bronze Valves
U-Bolt Gate Valves
Asbestos Packed Cocks
Bronze Radiator Valves
Sphero Ball Valves

CONSULT FAIRBANKS NEW CATALOG No. 42 FOR DETAILS



They Guard Against Interruptions of Service Due to Valve Failure

SERVICE: Recommended for service on steam, water, oil, gas and air lines. Available for steam working pressures from 125 to 200 lbs.

TYPES: Fairbanks *Renewable* Iron Valves are made with Bolted Bonnets, Rising and Non-Rising Stems, and have Composition Discs or Bronze Seat Rings.

FEATURES: The Seat Rings and Discs can be easily and quickly renewed when worn, without removing the valve from pipe line, at a small fraction of the cost of a new valve. Bodies and Bonnets have an average tensile strength of 38,000 lbs. per sq. in. Stems have *Acme* cut threads and are of generous proportions for strength and easy operation. Stuffing box is deep and can be repacked under pressure when wide open.

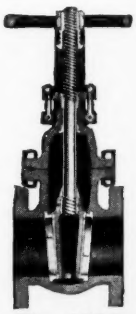


Fig. 0312

THE FAIRBANKS COMPANY

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BOSTON, MASS. PITTSBURGH, PA.

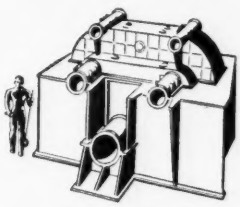
Distributors in Principal Cities

GEARED TO THE BIG JOB

Coupling Hendy marine turbines to the propellers that drive our "Bridge-of-Ships" are these smooth running Hendy reduction gears. Built to the highest precision-standards known in the American gear-cutting industry, they are produced in air conditioned, temperature controlled rooms—by time-saving, production-line methods.

Close meshing of these gears is typical of the coordination that exists among the "Iron Men of Hendy"—who have whole-heartedly geared their combined efforts to the "big job of today." Consistently ahead of schedules, they are delivering 2,500 hp and 2,750 hp steam engines and 4,000 hp reduction gear turbines. Soon they will be building even larger marine power plants—of over 8,000 horsepower.

When "the gears are shifted to peace," this skilled, dynamic organization will focus its efficient production methods on peace-time power—for industries that may need its skill and experience.



ANOTHER ACHIEVEMENT BY THE IRON MEN OF HENDY

. . . is the short time they required to erect plants, design tools, develop production methods, and the speed with which they are now delivering double-reduction gear units for marine turbines. The "bull-gears" for the 4,000 hp reduction gears are 104.6" in diameter, 14" helix; reduction ratio is 65:1.

JOSHUA HENDY IRON WORKS

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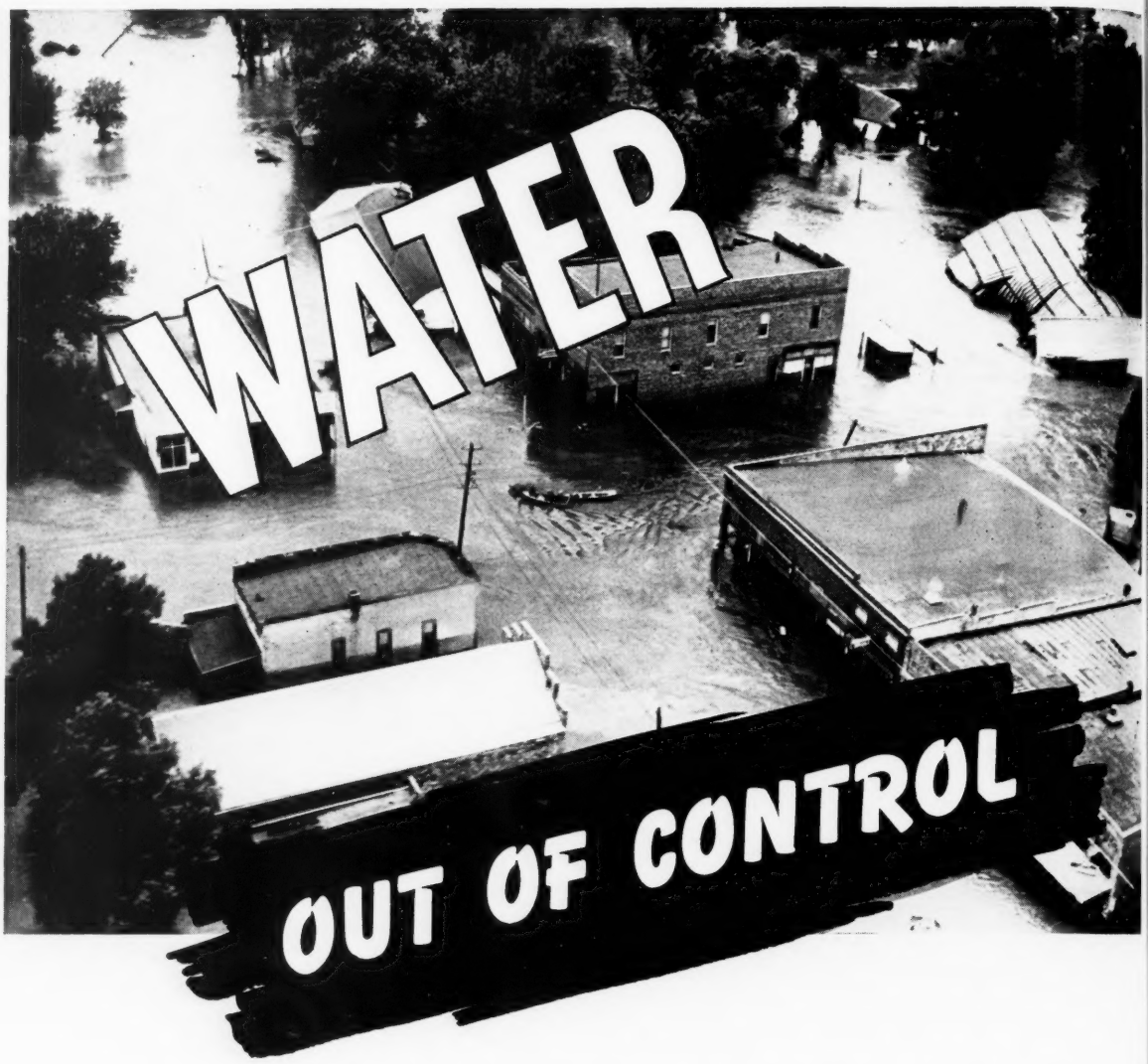

● Flood water is not the only "water out of control" which can leave crippling damage, irreplaceable loss or financial ruin in its path of destruction.

Water . . . uncontrolled . . . carried to vital spots in your plant, can ruin vital power plant equipment, play havoc with your production schedules or waste precious fuel.

Today, as never before, modern water conditioning is a "must" control against destruction by scale corrosion, embrittlement, carry-over, oil, etc.

You are invited to call on Infilco's Chemical Engineering Staff to help in any problem involving boiler or evaporator feedwater treatment, cooling water conditioning, condensate oil removal, steam purification, etc. There is no obligation.

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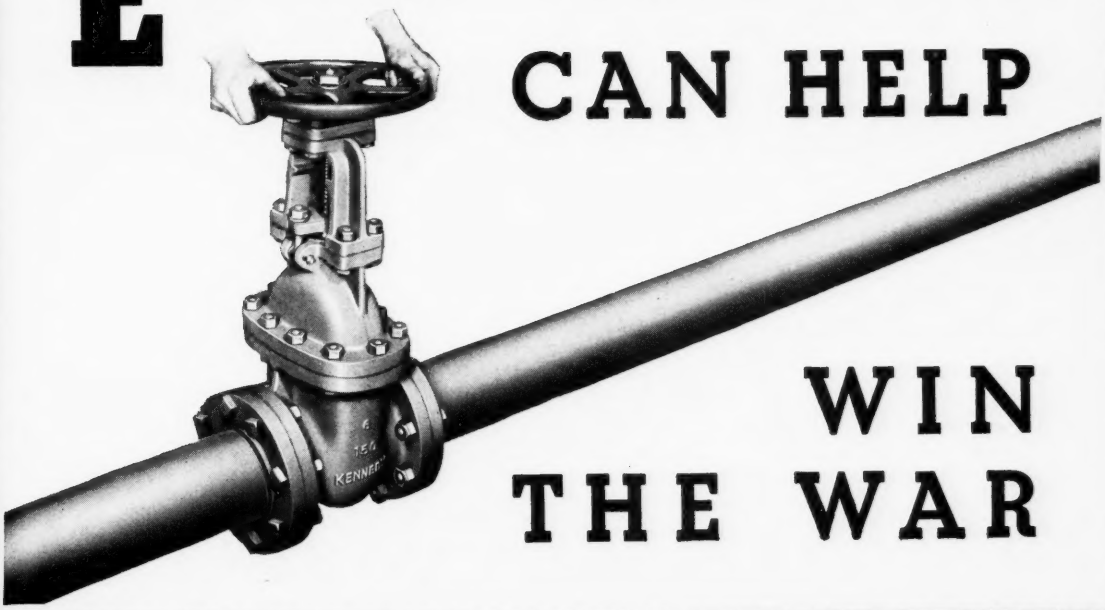
EVEN VALVES CAN HELP WIN THE WAR



Have you a copy of the 240-page Kennedy Catalog? If not, write us today . . . you'll find it helpful in selecting the right valves for your needs.

EASY operation . . . tight closure . . . dependable service . . . freedom from maintenance expense . . . convenient adjustments . . . these valve characteristics help to make a plant run smoothly and keep production up to schedule.

You are sure of all these characteristics with Kennedy Valves. Their sturdily built bodies have a generous margin of strength for rated pressures . . . their simple, accurately machined operating mechanisms respond unfailingly and securely . . . their large handwheels, deep stuffing boxes and specially designed stem threads provide convenient manipulation . . . and each type has several distinctive features for better, longer service.

You are safe when you buy Kennedy Valves . . . iron-body and bronze in all standard types and sizes.

THE KENNEDY VALVE MFG. CO.
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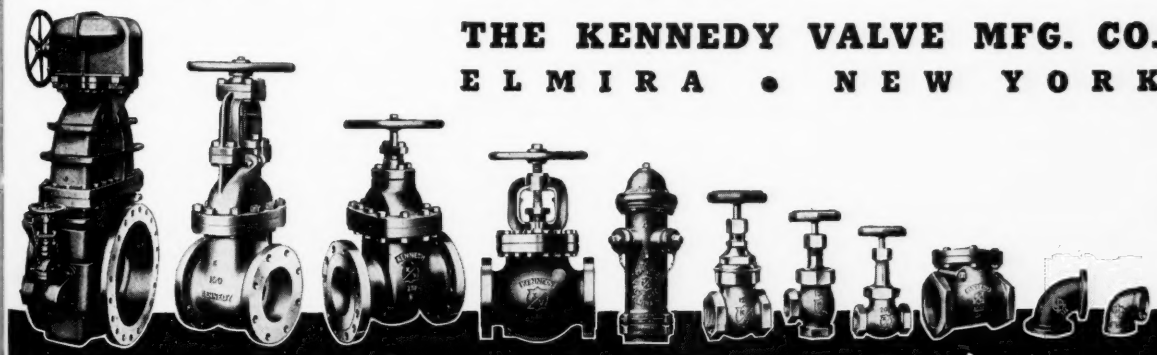

KENNEDY *valves . . . pipe fittings . . . fire hydrants*

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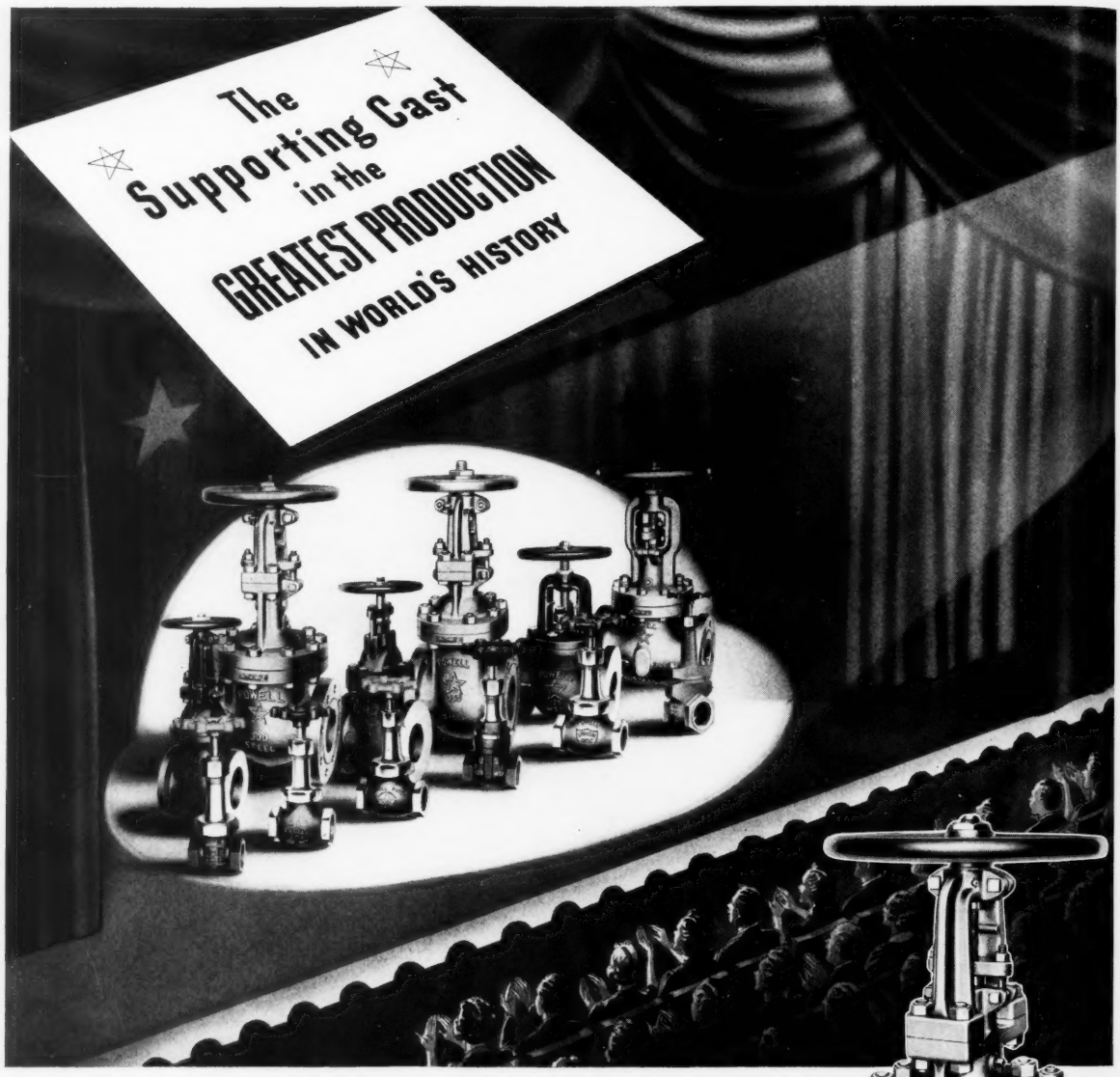

In the colossal job now being accomplished by American industry, every man, every machine, every piece of equipment plays an important part. And every one knows that Industry can give no better performance than the valves which control the fluids or vapors that give Life to Industry. The supporting cast in the greatest production the world has ever seen consists of—Valves. To this role, Powell brings the KNOW-HOW of 97 years of specialization in valve engineering . . . specialization in valve design, function, application, conservation . . . specialization in improvement of workmanship and materials through a period of almost a century. That's why today Powell Valves are giving a faultless performance in the epic drama of American wartime production.

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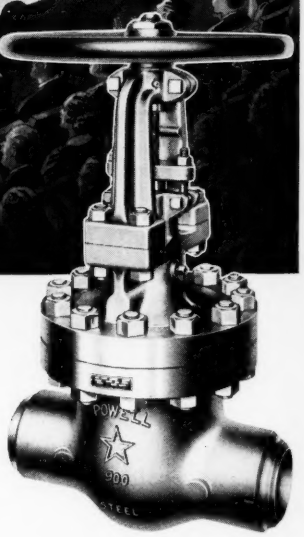
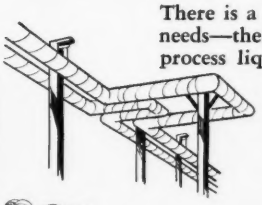


Fig. 9003 W. E.—Class 900 pound Cast Steel Gate Valve with welding ends, outside screw rising stem and bolted flanged yoke. Seat and disc are hard faced with Stellite.

POWELL VALVES

Ric-wil offers conduit for every need— the most complete line, meeting all conditions of service and cost

There is a Ric-wiL insulated conduit system engineered to your specific needs—the transmission of steam, hot water, oil, hot or refrigerated process liquids—providing heat transfer with the lowest possible loss.



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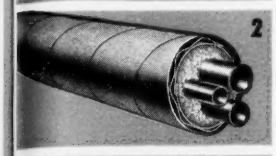
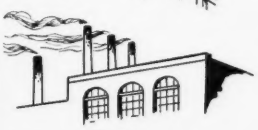
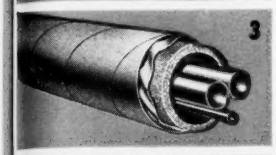
Prefabricated complete units—pipe as specified, thoroughly insulated, in helical corrugated conduit, coated and wrapped with asphalt saturated asbestos felt. 21-ft. lengths for speedy installation. For underground or overhead systems.

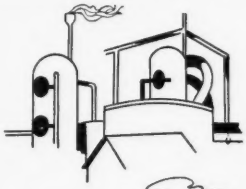




2. RIC-WIL INSULATED PIPE UNIT—MULTIPLE PIPE SYSTEM

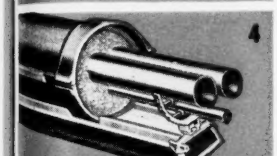
Any specified combination of pipes in prefabricated conduit—insulated and protected the same as the single pipe system. Any or all of the pipe lines may be specially insulated to meet job requirements.





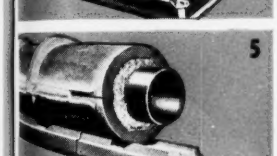
3. RIC-WIL INSULATED PIPE UNIT—FOR PROCESS LIQUIDS

An adaptation of the multiple system used where a steam or hot water line heats fluids in other lines. Pipes are insulated from the exterior but not from each other. Sizes and specifications as required—conduit same as for other insulated pipe units.



4. RIC-WIL STANDARD TILE CONDUIT—TYPE F

Vitrified glazed A. S. T. M. Standard Tile Housing—acid and waterproof —with foundation type base drain supporting weight of piping through correctly engineered pipe supports. Positive locked-in-place cement seals on sides and ends. For single or multiple pipes.

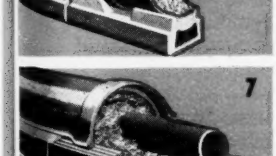


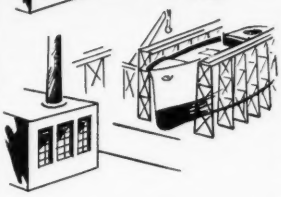
5. RIC-WIL SUPER TILE CONDUIT—TYPE F

Same advantages as Standard Tile but with walls approximately double thick for strength under heavy traffic or where overhead load is above normal. Will support concentrated static load of 6 tons per wheel under actual installation conditions. Base drain of extra-heavy tile.

6. RIC-WIL CAST IRON CONDUIT—TYPE F

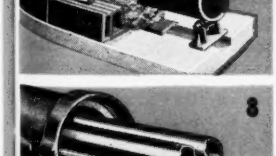
Heavy reinforced cast iron conduit for use where underground pipe lines run close to or under railroad tracks. Durable, water-tight and vibration-proof. Positive locked-in-place cement seals on sides and ends with metal clamps for extra tightness.

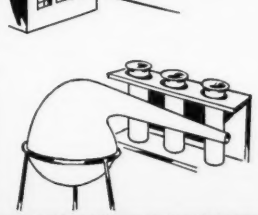




7. RIC-WIL TILE CONDUIT—UNIVERSAL TYPE

Where installation conditions dictate the use of a concrete pad Ric-WiL Universal Tile is recommended. Side walls are double-cell vitrified trapezoidal block design. Arch may be Standard Tile, Super-Tile, or Cast Iron.





8. RIC-WIL TILE CONDUIT—TYPE DA

For oil or process liquids where conduit must be insulated but individual lines are not insulated from one another. Insulation is a diatomaceous earth lining, moulded and keyed to inside of tile. May also be used (Type DF) with fibre insulation for steam heat, power and superheated steam. Applicable to Standard, Super-Tile and Cast Iron.

Ric-wiL accessories are available in all type systems; standard and special fittings, factory fabricated or field fabricated expansion devices, alignment guides, and anchors. Descriptive bulletins on request.

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THE RIC-WIL COMPANY · CLEVELAND, OHIO
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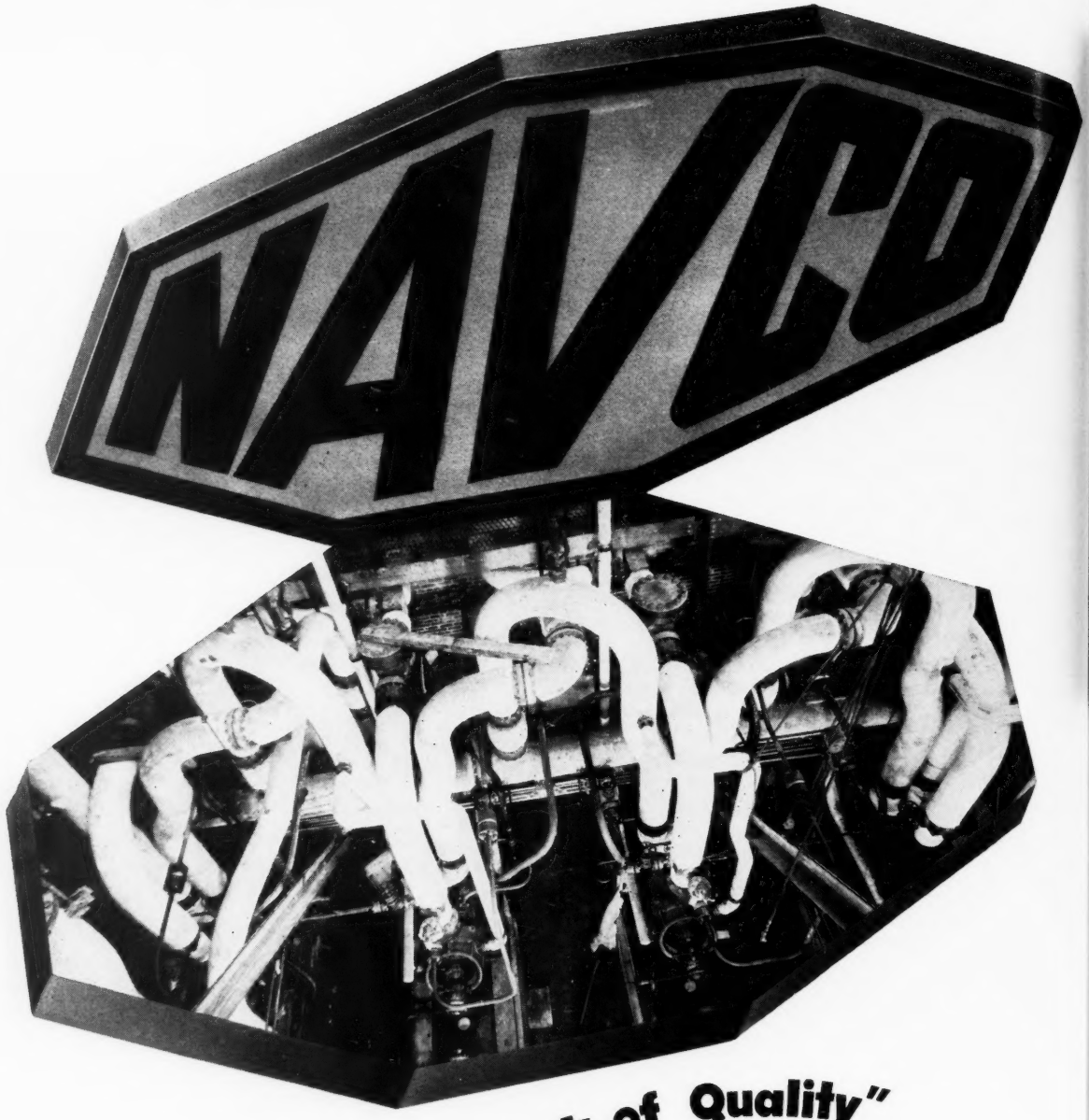

"Under the Navco Mark of Quality"

For the past thirty-five years Navco has been a mark of quality in the Piping Field. This quality service is available to you whether you require a single pipe bend or a complete High Pressure-High Temperature Installation. Consult Navco for your next Piping job.

NATIONAL VALVE & MANUFACTURING CO.
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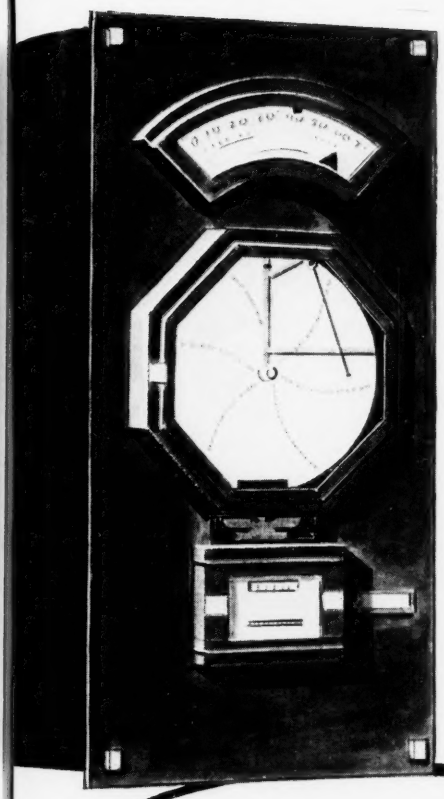

"Sure, we're carrying heavy loads, but GOOD WATER protects our boilers"

Scale and corrosion in boilers, steam lines and auxiliaries could cripple a power plant's war effort—might cause indefinite shut-downs if tubes could not be replaced. At thousands of war plants, Permutit prevents these troubles. Permutit removes the feedwater impurities that cause the damage. Writes one plant: "Inspection after a full season's operation shows boilers clean as new metal."

Permutit service covers every water conditioning process—including Zeo-Karb,* hot lime soda softeners, deaerating heater, silica removal, continuous blow-off equipment and the new demineralizing process. Let Permutit help *your* plant insure its continued contribution to war production. Write us about your water problem. The Permutit Company, Dept. A, 330 W. 42nd St., New York, N. Y. In Canada: Permutit Company of Canada, Ltd. . . Montreal . . Toronto . . Winnipeg . . Calgary.

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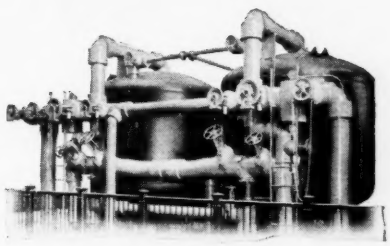

Permutit Zeo-Karb H water conditioner removes both hardness and bicarbonates from raw water. The effluent is reduced in total solids and alkalinity. The sulphate-carbonate ratio may be adjusted by mixing effluents from a Zeo-Karb H unit and a sodium Zeolite unit.

PERMUTIT

WATER CONDITIONING HEADQUARTERS

Serving Industry and the Armed Forces . . . with GOOD WATER

In War Industries and in Power Plants
In Fighting, Transport and Merchant Ships
In War Transportation, Locomotives and Other Units

GLOBE STEEL TUBES IN GLOBAL-WAR SERVICE

The "emergency" found *Globe Steel Tubes* prepared... prepared because *Globe* engineers are veterans of more than 30 years' constant service on the pressure-tube "front."... Concentrating now, as always, on *Globe Quality* steel tubes, we faced no problem of "conversion" to meet the unprecedented demands of industry's war-production power plants... transport, merchant and warships...locomotives and other units of war power-equipment requiring super-quality and 24-hour-a-day operative ability in boiler tubes, condenser and heat-exchanger tubes, stainless and mechanical tubing.

GLOBE engineers offer their long experience and superior facilities to aid you in selecting steel tubes of proper characteristics for your specific needs.

★ STAINLESS TUBES
★ BOILER TUBES
★ GLOBEIRON TUBING
★ GLOWELD TUBES

GLOBE TUBES

★ CONDENSER AND HEAT EXCHANGER TUBES
★ MECHANICAL TUBING

GLOBE STEEL Tubes

GLOBE STEEL TUBES CO., *Milwaukee, Wisconsin, U.S.A.*

STEAM PRODUCTION *vs.* MAINTENANCE

Steam and yet more steam for the production of ships, planes, tanks, guns and munitions has been the vexing problem for two long years. Installation of new power plant equipment has been neglible —shortage of materials prevents it.

One solution remains—the harder driving of existing equipment without outages for repairs. It is to the everlasting credit of Power Maintenance Crews that plant shutdowns for lack of steam have been virtually unknown.

Much of the nation's steam generating equipment is old; it is driven at a higher rate than it was designed for, with the result that greater maintenance and longer shut-downs are inevitable.

How then to insure maximum production?

The Answer is...PREVENTIVE MAINTENANCE

Plan carefully, inspect continuously; take every possible stitch in time. Consult manufacturers of your equipment as they have valuable suggestions to offer.

SEND FOR BULLETIN ON "PREVENTIVE MAINTENANCE"

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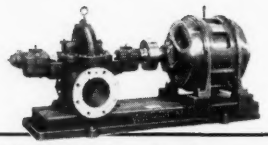


Fighters on the WARREN PUMP Production Front . . No. 3 of a Series

CHARLIE DOESN'T HAVE TO DO IT BUT HE DOES IT . . FOR UNCLE SAM

Charlie Ball was, *and is now again*, a Warren Pump toolmaker extraordinary.

It's this way. After more than 30 years of loyal, skillful service here at Warren, Charlie retired to take his well-earned ease . . . or do whatever else he pleased.

When our country was attacked . . . our Navy, our Merchant Marine, our War Industries needed more and more Warren Pumps. And Charlie, prompted only by his heart and patriotism, came back to help. With all his skill and experience, he is making a *real* contribution to the defeat of the Axis.

Charlie Ball and Warren Pumps have much in common . . . both are "built to fit the job" and can be counted upon for a long lifetime of reliable and economical performance.

WARREN PUMPS

WARREN STEAM PUMP COMPANY, INC.
WARREN, MASSACHUSETTS

KEEP THEM PUMPING

(*Continued from page* 71)

noise or a succession of light pings which may eventually result in a damaged impeller or badly worn bearings. A reciprocating pump will usually pound to the detriment of valves and bearings.

When a pump operates with a suction lift, creating a partial vacuum, liquid enters the pump because of atmospheric pressure on the surface of the liquid at the source of supply. The height of such a column of liquid is therefore limited to the equivalent of atmospheric pressure.

The maximum theoretical suction lift with cold water at sea level is about 34 ft. The suction lift practical under actual pumping service will vary widely with the style and design of the pump and the capacity at which it is operated. For cold water the average centrifugal pump is recommended for a maximum suction lift of about 15 ft. and a reciprocating pump about 20 ft.

Hot water can be pumped only under favorable suction conditions. When a liquid is handled at or near its boiling point a suction lift is impractical since the pressure at the pump suction is below atmospheric pressure (a partial vacuum) and the liquid will vaporize. Generally a net positive suction head is necessary to prevent vaporization.

The accompanying table illustrates the positive suction head required and the maximum attainable suction lift with a short and direct suction pipe of adequate size when pumping water at various temperatures. Since it is impractical to apply such general information to centrifugal pumps, this table applies primarily to pumps of the positive displacement type; and this data should be used only as a guide. On any questionable installation involving a high suction lift or the pumping of hot liquids with limited positive suction head it is wise to consult the pump manufacturer.

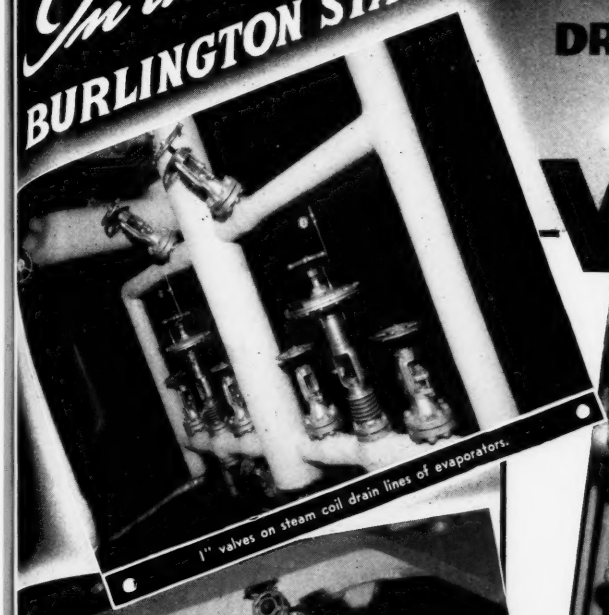
Often the foregoing limitations are overlooked. Frequently the offender is a suction pipe too long or too small; and excessive pipe friction adds too much to the suction lift or cuts down the effective positive suction head.

Make sure that none of your pumps are starved because of a poor suction condition.

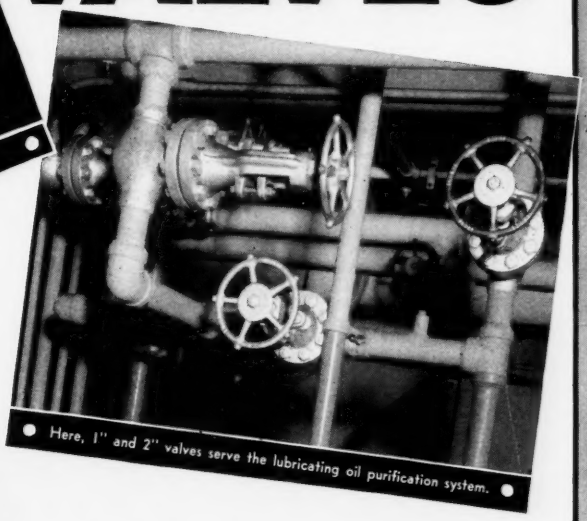
(To be concluded)

In the line at
BURLINGTON STATION

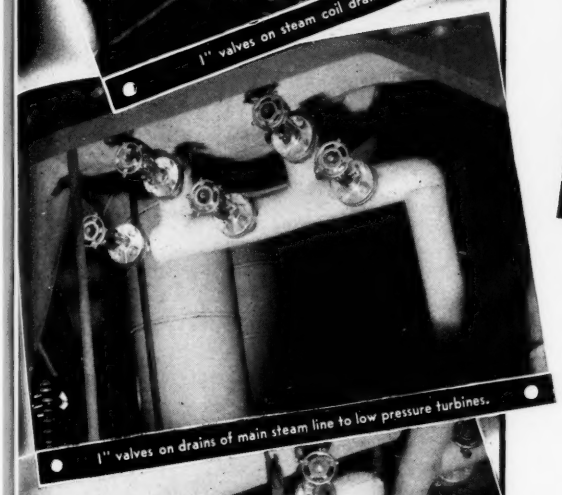
Vogt
DROP FORGED STEEL
VALVES



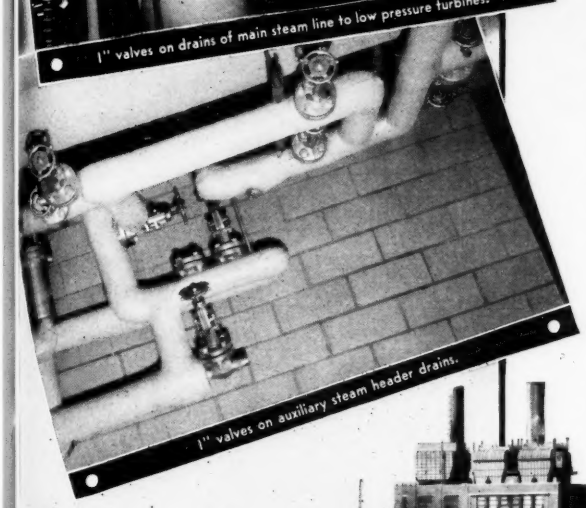
1" valves on steam coil drain lines of evaporators.



Here, 1" and 2" valves serve the lubricating oil purification system.



1" valves on drains of main steam line to low pressure turbines.



1" valves on auxiliary steam header drains.

Unit No. 5 at the Burlington Generating Station of the Public Service Electric and Gas Company has recently been placed in service. It consists of two 550,000 lb.-per-hour boilers which supply steam at 1,250 lb. and 950 deg. F., a 125,000-kw. condensing turbine-generator operating at 3,600 rpm., and the necessary auxiliary equipment.

Vogt *drop forged steel* socket weld end valves, as illustrated here, play an important part in the smooth, dependable functioning of this modern power plant.

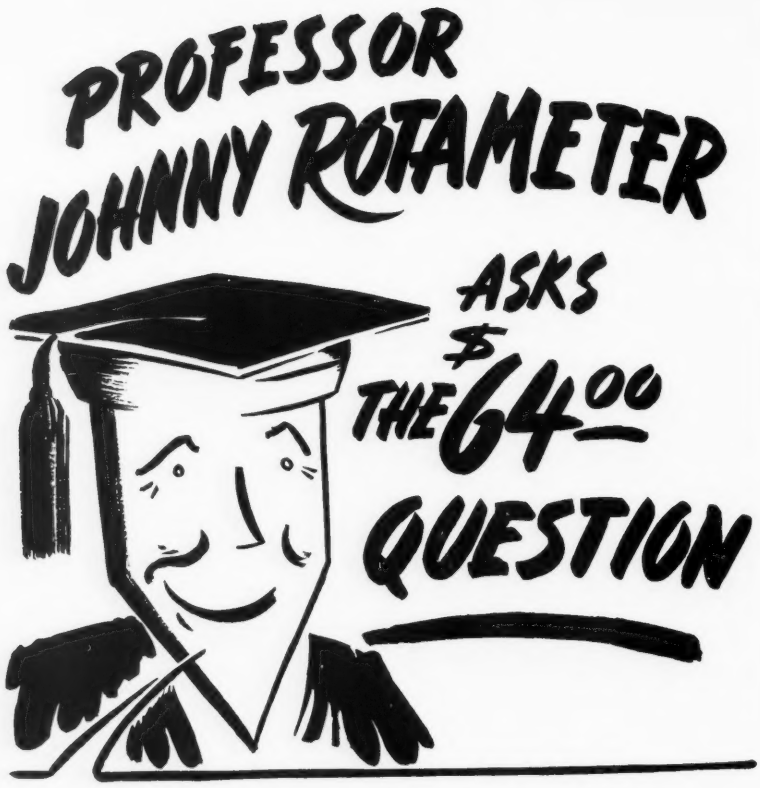
Catalog F-8 sent upon request.

HENRY VOGT MACHINE COMPANY
Incorporated
LOUISVILLE, KENTUCKY

Branch Offices: New York - Philadelphia - Cleveland - Chicago - Dallas

General view of Burlington Generating Station of the Public Service Electric & Gas Company.

XUM



What flow rate instrument combines these features?

- .....high visibility
- .....instantaneous response
- .....low, constant pressure drop
- .....10″ to 24″ scale length
- .....evenly-spaced scale divisions
- .....20 to 1 flow range
- .....low maintenance
- .....ability to measure any corrosive gas or liquid
- .....overall accuracies as high as 99.8%

The answer is obvious — only the rotameter can offer all of these advantages in one instrument.

If you are not utilizing the rotameter to your fullest benefit, it is perhaps because you have not realized yet how superior it is to fixed orifice meters for flow rate measurement. Furthermore, the scope of the rotameter is being widened constantly by our research and by our experience in its application to industry. Today, for instance, the remote recording and automatically controlling rotameter is a standard item with us.

Put yourself abreast of the latest rotameter developments by writing for our booklet No. 10-A entitled "A New Trend in Flow Rate Measurement." It is concise and worth reading. We will gladly send it to you without any obligation whatsoever.... Fischer & Porter Company, 595 County Line Road, Hatboro, Pennsylvania.

F&P ROTAMETERS

Semi-Annual A.S.M.E. Meeting at Los Angeles, June 14-17, to Feature Aviation Problems

AVIATION will steel the show at the 1943 Semi-Annual Meeting of The American Society of Mechanical Engineers, scheduled for June 14-17, at the Hotel Biltmore, Los Angeles, Calif.

Present plans calls for a luncheon on the opening day of the meeting at which W. F. Durand, past-president and honorary member, A.S.M.E., and member of the National Advisory Committee for Aeronautics, will preside. Subject of the luncheon addresses will be Combat to Cargo Airplanes.

Two sessions on Women in Industry and Engineering will be addressed by I. J. Hanson, Vultee Aircraft Corp., by C. W. Cole, Wright Aeronautical Corp., by E. D. Howe, supervisor, E.S.M.W.T., University of California. R. F. Gagg, Wright Aeronautical Corp., will present a paper on the management problems at the Wright plant.

Hydraulics in Airplane Systems

Three papers on hydraulics are listed: A Symposium on Airplane Hydraulic Systems, by Howard Field, North American Aviation Corp., Hydraulic Versus Electric Operation of Aircraft Units, by Richard Hayman, Lockheed Aircraft Corp., and The Modern Hydraulic Reservoir; How It Provides Micron Filtration and Pump Supercharging, by W. W. Thayer, Douglas Aircraft Company.

In the field of heat transfer, F. Ryder, R. R. Martinelli and A. E. Harrison, University of California, will present a paper on The Hot-Wire Anemometer and Its Application to the Measurement of Intake-Manifold Velocities. A. L. London, Stanford University, is scheduled for a paper on the Design and Calibration of a Thermal Anemometer; and M. E. Moore, Douglas Aircraft Co., one on Automatic Temperature-Recording Control System. Other papers sponsored jointly by the Aviation and Heat Transfer Divisions will include Test and Predicted Behaviors of Engine Oil Coolers, by A. L. London, Stanford University, and Aircraft Heating and Ventilating Systems, by W. W. Reaser, Douglas Aircraft Co.

Superchargers to be Discussed

Two papers have been arranged for in the field of superchargers, one by R. G. Standerwick and the other by Sanford A. Moss, both of the General Electric Co.

The tentative program includes a panel discussion on production headed by T. A. Watson, University of California, with panel members representing Douglas, Vega, Lockheed, and Vultee.

At another production-engineering session, W. Schroeder, Lockheed Aircraft Corp., will speak on the Mechanics of Sheet-Metal Bending, and P. L. Smith, of Douglas Aircraft Co., on Metal Forming Technique.

Dr. S. Timoshenko, Stanford University and Dr. Th. von Kármán, California Institute of Technology, are scheduled to appear at the same session on the joint Aviation-Applied Mechanics program. Dr. Timoshenko's subject is, Problems of Elastic Instability in Aircraft Structures. Dr. von Kármán's paper will deal with Nonlinear Instability Problems in Aircraft Structures.

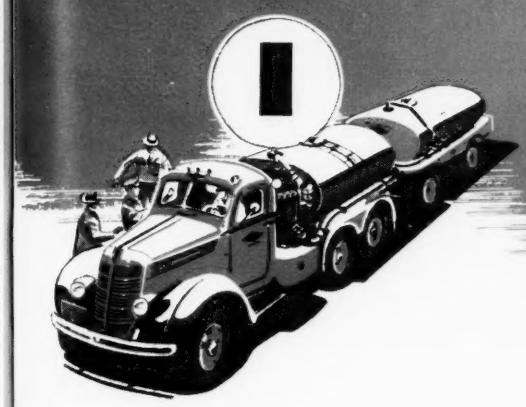
TWO BIG REASONS

WHY INDUSTRY INDORSES

DOWELL

INDUSTRIAL SCALE REMOVAL SERVICE

. . . THE SERVICE THAT SAVES TIME, MANPOWER AND EQUIPMENT



SPECIALLY ENGINEERED MOTORIZED EQUIPMENT

To provide Dowell Industrial Scale Removal Service to Industry—and eliminate the necessity of dismantling the equipment to be cleaned—Dowell operates a fleet of specially designed motorized units. This equipment—manned by competent, well-trained engineers—is equipped with special pumps, tanks and fittings for handling chemical solutions quickly and efficiently.

☆ ☆ ☆

Write Dowell's Tulsa office about your scale removal problems

DOWELL INCORPORATED

General Offices: Kennedy Bldg., Tulsa, Oklahoma

Subsidiary of The Dow Chemical Company

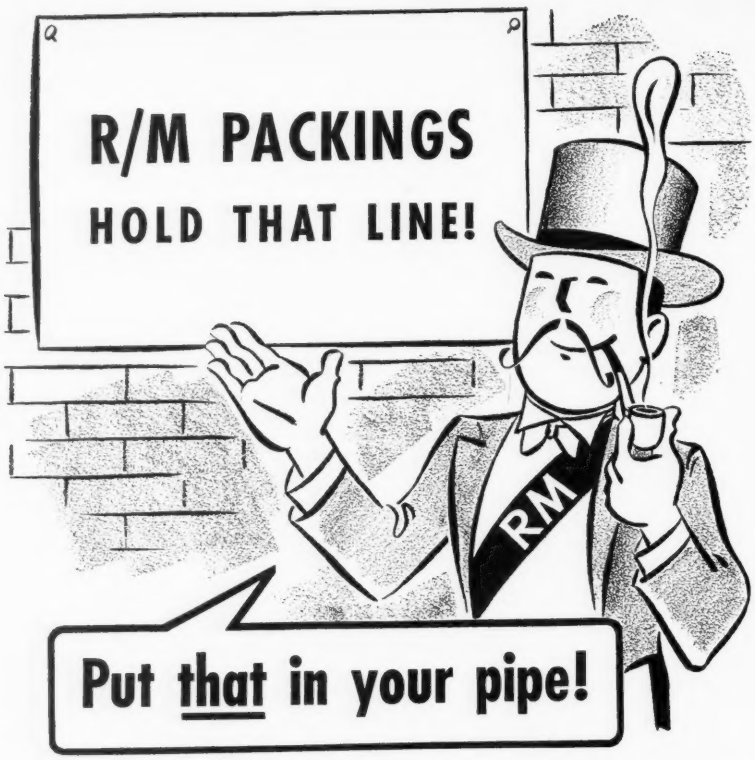
FIELD STATIONS FOR FAST SERVICE

Dowell maintains field stations in many states where chemicals are stored and mobile equipment is serviced. Analytical devices are available at these stations for determining scale compositions and with this information the best type of scale removal solvent can be selected.

Look to

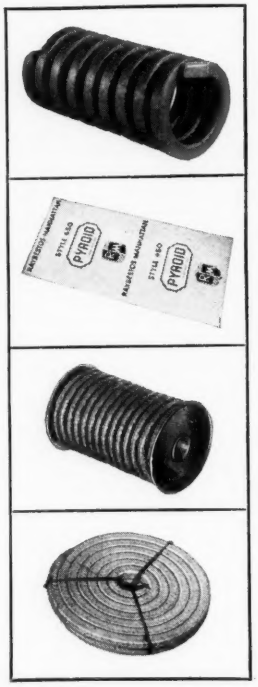
DOWELL

FOR INDUSTRIAL CLEANING AND SCALE REMOVAL SERVICE



Under the forced draught of war production, pipe-lines have to stand up under increased pressures. It is the patriotic duty of R/M packings to see that the steam, air, fuel, or oil gets where it's going, without blowouts and leaks through faulty seals. And these packings do their duty!

Lights burn brightly in R/M laboratories as engineers work early and late to improve these products for the stepped-up jobs to be done. Practical experience in the field adds to their knowledge, too, and the net of it all is better packings for every purpose.



Awarded to R/M North Charleston Plant

Do you have a copy of the R/M catalog? It's keyed for applications, illustrated, and indexed as to materials and types. Ask your jobber.

INDUSTRIAL SALES DIVISION
RAYBESTOS-MANHATTAN, INC.
MANHEIM, PA.
BRIDGEPORT, CONN. NORTH CHARLESTON, S. C. PASSAIC, N. J.
Makers of Packings for Every Industrial Use

Harbor Steam Plant

(*Continued from Page* 116)

ces of the plant. The control house is of reinforced-concrete construction, completely enclosed and independent of daylight as it contains its own ventilating and lighting system. The control room, Fig. 8, follows the same general design used by the Bureau in all its receiving stations. It contains all the switchboards for controlling the main generator, the main power switchgear and also the main feeds to the auxiliary switchgear. The auxiliaries themselves are controlled at convenient locations throughout the plant.

Control cables from the steam plant enter the basement of the control house via underground duct lines and are routed on steel racks and trays to terminal cabinets located immediately below the switchboards.

The switchboards in the main control room are arranged in four units. The first switchboard controls the main turbine generator. The second board controls the power-supply breakers to the auxiliary buses. The third board contains recording temperature instruments, time-frequency control equipment (future) and miscellaneous recording devices. The fourth board controls the d-c control battery system.

Two separate 640-amp-hr, 250-v, lead-acid type storage batteries, together with their charging equipment, located in the basement of the control house, furnish the service for the control of the plant equipment and also supply a complete emergency lighting system throughout the control house and the steam plant proper.

The communication system consists of three independent units: The first is an intercommunicating P.A.X. telephone system with phones widely distributed throughout the entire plant area; the second, a manual telephone system furnishing direct communication between major control points in the steam plant and the control house; the third, a means of communication employing luminous panels by which the operators at key points exchange messages.

Transil Oil System

A transil oil storage and reconditioning system is installed in an underground vault approximately 100 ft north of the main building. This system consists of three 12,000-gal storage tanks, two 50-gpm filter presses, one filter paper dry-

(*Continued on Page* 144)

WeldELLS

have everything ★

"You said it, brother—EVERYTHING!"

His job is *welding;* not fooling around getting ready to weld.

He can put more time on actual welding when he uses WeldELLS:*

—Because their tangents make them easier to line up.

—Because their precision quarter-marked ends simplify layout.

—Because the size and thickness are permanently marked on every fitting.

He can turn out a better job, too, when he uses WeldELLS—thanks to their dimensional accuracy and to the machine tool beveled ends that provide an ideal welding surface.

And the features that mean so much to the welder are also vitally important to the men who engineer the job and those who live with it.

★ No other fittings for pipe welding combine these features found in WeldELLS:

- **Seamless** — greater strength and uniformity.
- **Tangents** — keep weld away from zone of highest stress — simplify lining up.
- **Precision quarter-marked ends** — simplify layout and help insure accuracy.
- **Selective reinforcement** — provides uniform strength.
- **Permanent and complete identification marking** — saves time and eliminates errors in shop and field.
- **Wall thickness never less than specification minimum** — assures full strength and long life.
- **Machine tool beveled ends** — provides best welding surface and accurate bevel and land.
- **The most complete line of Welding Fittings and Forged Steel Flanges in the World** — insures complete service and undivided responsibility.

* WeldELLS and many other Taylor Forge products are produced in Byers Genuine Wrought Iron.

TAYLOR FORGE & PIPE WORKS, General Offices & Works: Chicago, P. O. Box 485

* The list of Taylor Forge's contributions to the war effort only begins with WeldELLS. One of many examples is Taylor Corrugated Marine Furnaces, essential to many merchant ships and transports.

NEW YORK OFFICE: 50 CHURCH ST. • PHILADELPHIA OFFICE: BROAD ST. STATION BUILDING

When You Use

B-H MONO-BLOCK INSULATION

Here is the ideal insulation for boilers, turbines, engines, ovens, furnaces and other high temperature installations all the way up to 1600° F. No other insulation gives you all these important advantages:

HIGH TEMPERATURE PERFORMANCE
Made from special *black* rock-wool, MONO-BLOCK refuses to break down under much greater heat than many other types of insulation can stand.

MOISTURE RESISTANCE
This same special *black* rock-wool makes possible a block which is highly resistant to moisture and does not disintegrate. You are assured of permanence of physical properties and retention of high insulating values even though MONO-BLOCK is exposed to humid conditions.

WIDER SERVICE RANGE
As its name indicates, MONO-BLOCK eliminates the necessity for one type of block for temperatures up to 600° F. and another type for temperatures above 600° F. MONO-BLOCK does the job for both.

LOW CONDUCTIVITY
Exceptionally low conductivity is another MONO-BLOCK characteristic that pays big dividends. This is made possible through an exclusive, patented felting process, which produces a low density block.

EASY TO INSTALL
Sufficiently rigid to support its own weight and yet yielding enough to absorb surface irregularities, MONO-BLOCK produces a neat, snug job with little effort. B-H BOND-TITE adhesive simplifies the application of the block.

Check for yourself these practical advantages. Send for generous samples of B-H MONO-BLOCK and B-H BOND-TITE Cement. Just write us on your regular letterhead. Do it now.

BALDWIN-HILL *Insulations*

577 KLAGG AVE. TRENTON, N. J.

NEW YORK CHICAGO KALAMAZOO

(*Continued from Page* 142)

ing oven and a drain-and-fill circulating pipe system with connections for all the transil oil-filled equipment, both inside and outside the main building.

Fire Protection System

A Cardox system has been installed to protect various points throughout the main building regarded as fire hazards. The system provides a storage tank capacity of four tons of CO_2 which is maintained at 300 lb psi gage by refrigeration. Each hazardous location is protected by a number of nozzles which admit CO_2. Thermostats at these locations control the valves for admission of liquid CO_2 to the nozzles. The quantity of CO_2 admitted to the hazard is regulated by an automatic timing device.

The oil storage tanks on the site are protected by enclosing concrete fire walls and a foam system. The foam is supplied by two generators installed in a separate building located 100 ft from the fire walls.

Design and construction of the Harbor Steam Plant were under the supervision of H. C. Gardett, Chief Electrical Engineer and General Manager and R. R. Robertson, Engineer of Design and Construction of the Los Angeles Bureau of Power and Light.

Chicago Section A.S.M.E. Holds Annual Meeting and President's Night

FEATURED by an interesting message dealing with the present and future effects of new scientific discoveries on mechanical engineering, by Harold V. Coes, president of the Society, and an address on Problems of Global Air War by Lieut-Col. Nathaniel F. Silsbee, U. S. Army Air Corps, the annual meeting and president's night of the Chicago Section ASME was held at the Medinah Club, Chicago, Ill., on the evening of April 28, 1943.

President Coes reviewed briefly the tremendous expansion that has occurred in our production of aluminum and magnesium as a result of war demands, which have led to the development of many new techniques in the production of these and other materials. Our capacity to produce these materials in tremendous quantities will, he believes, have the most profound effect on the work of the mechanical engineer in the future. He called attention to new alloys of tremendously increased ultimate strengths, discussed new metal fabricating techniques and showed how these, together with developments in the plastics field, are bound to produce far reaching changes in all mechanical engineering work. Because of all these things, Mr. Coes said, he feels our economic system is extremely dynamic and capable of even greater expansion in the years ahead than we have seen in the past.

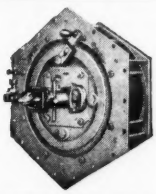
No. 2 in a series of tributes to America's War Industries

MAKING MINCE-MEAT OUT OF PANZERS!

They jab and stab, they slug and smash. On and on they roll . . . devouring Nazi panzers as they go . . . leaving in their wakes the shattered, burned-out carcasses of these mechanical beasts. Lights, mediums, heavies . . . Lees, Shermans, Grants . . . they outspeed, out-shoot, out-maneuver, out-last anything the frantic "supermen" can create. These are the tanks that American industry builds.

In quality, the world has never seen their equal. In quantity, this vital tool of war is coming off our production lines like pennies out of a mint. For both, the civilized world can thank American industry . . . its genius for producing the most of the best.

And what this genius is doing for tanks, it is also doing for planes, guns, ships, ammunition . . . every phase of our war production. American industrial might . . . all its muscle, all its skill, all its determination . . . is all-out for the blood of the Axis!



IN PLANTS OF ALL TYPES

TODD BURNERS

ARE WORKING FOR VICTORY

Wherever trouble-free, dependable combustion of liquid and gaseous fuels is a necessity . . . in war plants, in countless merchant and fighting ships . . . Todd Burners are delivering unsurpassed performance in the production of heat and power.

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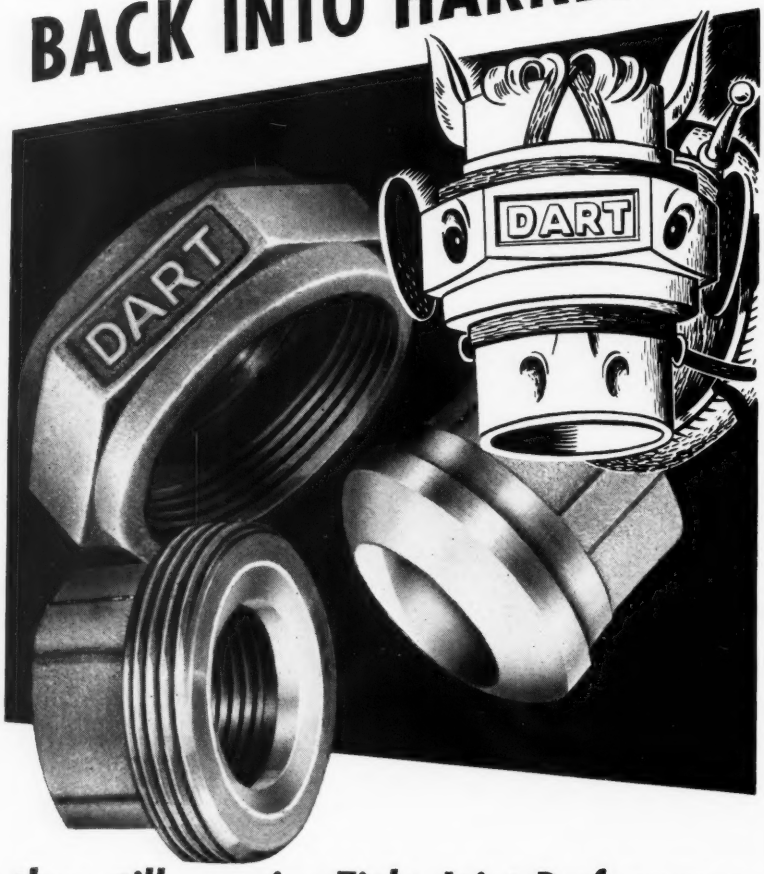
TODD BURNERS ★ ★ ON THE FIRING LINE OF AMERICA'S WAR PRODUCTION FRONT

Put Your Old Darts BACK INTO HARNESS...



they *still* can give Tight-Joint Performance

Dart Unions are "work-horses" . . . they can be used over and over again. Even Darts that have served long and faithfully enough to be "retired to pasture" can still be counted on to give "tight-joint" performance.

Look at the illustration. It shows the two famous Dart extra-wide bronze seats, ground to "true-ball accuracy" . . . one reason why a Dart has long life and unusual performance. Another important reason is the fact that Dart bodies and nuts are made of air-refined malleable iron that resists pipe strains, rust and rough handling.

For the sake of metal conservation and the war effort, keep searching for used Dart Unions . . . and put them "back into harness." If you need *new* Darts, see your supplier today.

DART UNIONS

E. M. DART MANUFACTURING CO., PROVIDENCE, R. I.

Demonstrating an intimate knowledge of all the conditions of global air war, Lieut.-Col. Silsbee outlined the present organization of our various air forces in all parts of the world, told why they are in their present locations, what their functions are at present and what they are expected to be in the future. He gave details of the present types of airplanes now used on the various fighting fronts, showed how these have been developed from the early models and discussed the improvements made in the latest models and the way in which these are being manufactured in tremendous quantities and are now beginning to reach the fighting fronts. He closed with a very interesting series of colored lantern slides of all types of British and American planes and answered a number of questions from his much-interested audience.

The Chicago Section Student Award for 1943 was presented by J. R. Michel, Chairman of the Section, to John R. Cronin, Illinois Institute of Technology, for his work in building up the ASME student branch in one year from a membership of 173 to 254. Mr. Cronin was graduated from the Institute in mechanical engineering in February 1943 and is now serving in the U. S. Army.

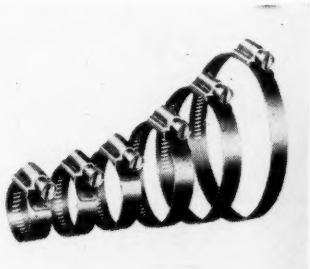
At this meeting, the section elected the following officers to serve for the season July 1, 1943, to June 30, 1944: Chairman, J. P. Magos, Directing Engineer, Research and Development Laboratories, Crane Co.; Vice-chairmen, Major H. M. Black, U. S. Army; F. H. Lane, Manager Engineering Division, Public Utility Engineering & Service Corp.; J. C. Marshall, Plant Engineer, Procter & Gamble Mfg. Co.; P. A. Stephenson, Chief Engineer, Research & Development, A. B. Dick Co.; J. I. Yellott, Director, Department of Mechanical Engineering, Illinois Institute of Technology; Secretary-treasurer, Fred B. Orr, Assistant to President, Illinois Maintenance Co.; and an executive committee of 20 members.

NEW EQUIPMENT

Information that you desire about any equipment will be gladly furnished without obligation. WRITE POWER PLANT ENGINEERING

New Hose Clamp

A NEW LINE of "Aero-Seal" Hose Clamps in fourteen sizes from ¾ in. to 4 in. inside hose diameter, has recently been introduced by the Aircraft Standard Parts Co., Rockford, Ill. These clamps have been designed with a number of improved and interesting features. The basis of the



design was the requirements set forth in an Army Air Force Specification.

The "Aero-Seal" Hose Clamp con-

Special Monels with Superior Machining Properties

The strength and corrosion resistance of Monel are so well known that they require no comment.

But do you realize that in addition to *regular* Monel, there are two *special* Monels—"R" Monel and "KR" Monel?

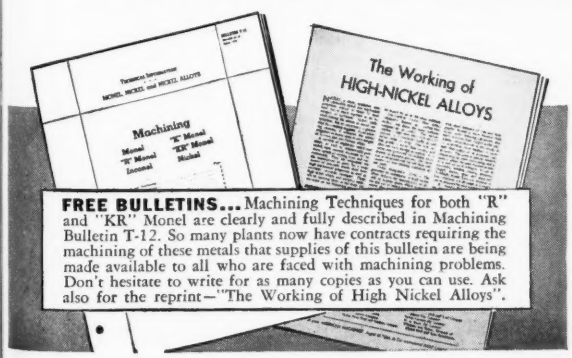
"R" Monel . . . When introduced several years ago, "R" Monel made available the properties of Monel coupled with improved machinability.

"R" Monel is readily fabricated by cold forming—is produced as hot-rolled and cold-drawn rounds, squares and hexagons. It is ideally suited for the automatic production of rust-proof screw machine parts, yet has mechanical properties equal to steel screw stock (S.A.E. 1112), and is actually tougher. "R" Monel is NOT heat-treatable. (See "KR" Monel below.)

"KR" Monel . . . The newest member of the Monel family, "KR" Monel, offers machining qualities you wouldn't expect to find in a metal with so many other superior properties—corrosion resistance combined with non-magnetic characteristics, plus exceptional hardness and strength that can result only from heat treatment.

"KR" should be used for screw machine products which are to be heat treated after machining. Remember "KR" Monel as the MACHINABLE brother of "K" Monel, long known for its great strength and hardness. The International Nickel Company, Inc., 67 Wall Street, New York, N. Y.

★ ***SAVE MACHINING TIME AND MONEY . . . Specify "R" Monel and "KR" Monel***



FREE BULLETINS... Machining Techniques for both "R" and "KR" Monel are clearly and fully described in Machining Bulletin T-12. So many plants now have contracts requiring the machining of these metals that supplies of this bulletin are being made available to all who are faced with machining problems. Don't hesitate to write for as many copies as you can use. Ask also for the reprint—"The Working of High Nickel Alloys".

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York, N. Y.

Gentlemen: Please send me copy of your Machining Bulletin T-12 and also the reprint "The Working of High Nickel Alloys."

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COMPANY _____ TITLE _____

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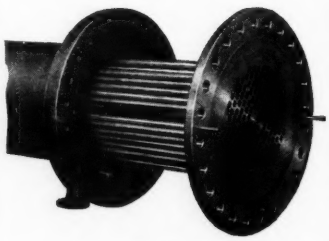
We have the spare capacity to go into immediate production on any special heat exchanger you may need. Construction can be of any type of material specified—for all types of liquids. Transfer of heat from liquid to liquid or steam to liquid, etc. Diameters up to 30″; pressures up 600 p.s.i.

Take advantage of this opportunity to get the heat exchanger you need. There are Henszey Company representatives in 32 leading cities listed under our name in the local telephone directory. Get in touch with any one of them, or write, telegraph or telephone direct to Watertown.

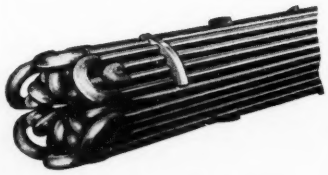
HENSZEY COMPANY
Dept. C 6, Watertown, Wis.

HENSZEY

HENSZEY
HEAT EXCHANGERS



Tube Sheet End of Exchanger



Return Tube Exchanger

CONTINUOUS BLOWDOWN SYSTEMS

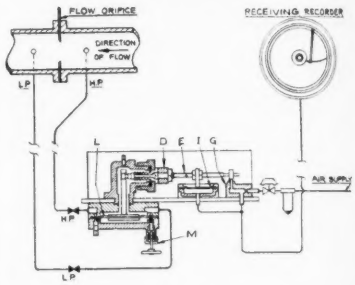
Boiler Feed Regulators • Feed Water Meters
Proportioning Valves • Flow Indicators

sists of a $\frac{3}{16}$-in. tempered steel band punched with holes corresponding to the teeth of a worm gear. These holes mesh with a worm in the housing welded to the fixed end of the band. The worm is turned by a screw driver, and the screw head on the worm is fitted with a safety cup which prevents the screw driver from slipping and puncturing the hose or damaging other equipment.

The safety cup feature not only prevents slipping of the screw driver but also makes it possible to find the screw slot easily in the dark or in cramped or concealed locations. Since the screw is hardened, the slot will not be damaged by repeated use.

Pneumatic Differential Pressure Transmitter

PNEUMATIC differential pressure transmitter for measuring flow and level has recently been announced by Republic Flow Meters Co., Chicago, Ill. The device converts a differential pressure, produced by flow of fluid through an orifice or by variations in liquid level, into an air pressure proportional to the differential pressure. This air pressure is used as a direct measure of the differential and is measured by a gage graduated in terms of flow or level or can actuate a controller. No mercury or sealing fluids are used in the transmitter.



Operating principle, shown in diagram, is that of a force balance. Differential pressure produced by flow, applied to diaphragm L, moves weighbeam E (which is pivoted on ball bearings), causing the throttle tip mounted on its right end to control air bleed from nozzle G until pressure under diaphragm I restores weighbeam E to balance. Motion of E, therefore, produces variations in pressure under diaphragm I proportional to changes in force produced by diaphragm L. The receiving recorder or gage measures these pressure variations and may be graduated in terms of flow or level. Receiver may be at any desired location up to 1000 ft away.

Movement of differential diaphragm L is approximately 0.010 in. for 100 in. water differential range; hence only minute fluid displacement occurs in differential chamber. Since no mercury or sealing fluid are used, there is nothing to be blown into flow lines by over-range. The meter chamber is sealed by a flexible bellows. Small diaphragm movements do not appreciably change the diaphragm areas, making calibration simple. The transmitter is inherently explosion proof and any electric chart drives required for receivers can be supplied in explosion-proof housings.

Transmitting pressure vs. measured differential is guaranteed within ½ of 1 per cent of meter range. Because of the small motions of parts, it is stated, no appreciable hysteresis results from the

FURNACE CONSTRUCTION FOR WARTIME SERVICE

Ten years ago the suspended arch shown in this photograph was built to prove that Detrick Detred Tile design was right. Notice the spalls in the upper section which was built with the old style Detrick tile showing the effect of severe furnace conditions. In the same arch the Detred area is practically as smooth and tight as the day it was erected.

It was a simple, logical step to put treads on all four sides of the tile and an inspiration to reverse the treads in alternate rows so that one shape of tile is held in position in two directions. The thin layer of joint material is held in position by the treads and thus adds to the airtightness.

No change has been made in the basic Detred Tile design in the past ten years and it is in use in thousands of furnaces on walls and arches helping to provide power and conserve heat for the war effort.

Every one of Detrick's construction principles has come as the result of trying to lick some particular problem in the control or conservation of heat. In 30 years of concentrating on this subject many hundreds of examples of practical engineering have been developed. Detred Tile is only one of them.

When you have a problem in enclosing heat, call on Detrick. Through the close teamwork in this organization of engineers you get the benefit of 30 years of experience in the development of enclosures for every type of furnace. Ask for the new Detrick Catalog just off the press.

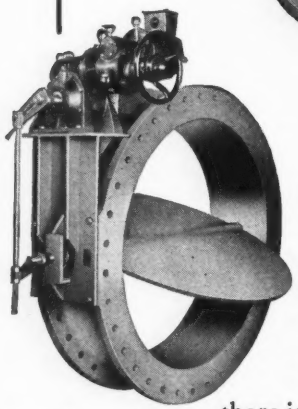
M. H. DETRICK COMPANY
140 South Dearborn Street, Chicago, Illinois

DETRICK FURNACE ENCLOSURES

Easy to Operate...

Streamlined for Self-Cleaning

16-inch cast iron chain wheel operated valve for pressures up to 15 pounds. Complete range of sizes from 2-inches to 84-inches.



Automatic electric-motor operated American Standard Valve with hand wheel for manual operation in case of current failure. Available in 125 lb iron, 150 to 900 lb steel.

The action of an R-S Butterfly Valve is rapid and smooth. Four to six revolutions of the hand wheel or chain wheel fully open or close the valve vane. The compact, inherently narrow face-to-face dimensions, and the fact that there is no long stem or gate well, reduce clearance requirements to the minimum.

There is free passage for direct flow with no restrictions other than the streamlined vane. Sediment cannot collect since there are no right angle bends or reverse turns. Hence, the R-S Valve is ideal for the control and shut-off of dirty gas, dirty water, pulverized fuel or similar flowing solids.

The beveled vane wedges tight against the valve body for shut-off duty.

Write for catalog and detailed information about the use of R-S metals for resistance against heat, abrasion and corrosion.

R-S QUALITY PRODUCTS SINCE 1908

15 to 900 psi

VALVE DIVISION

R-S PRODUCTS CORPORATION

4535 Germantown Ave. Philadelphia, Penna.

R-S Streamlined BUTTERFLY VALVES

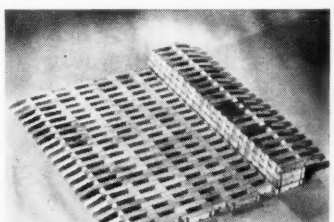
reversal of direction of measurement change, the hysteresis loop being less than 1/20 of 1 per cent. With 500 ft of ¼-in. O.D. tubing between the transmitter and a Republic receiver, the full value of a change in differential will register in 15 sec. Air consumption at zero differential is 0.20 cfm maximum at 20 psi supply pressure. Standard models are supplied for working pressures up to 600 psi special heads for pressures up to 2000 psi.

By changing diaphragms, diaphragm plates and diaphragm leverages on the weighbeam, transmitter can be adapted to any desired range between 0.9 in. and 800 in. of water differential. Diaphragms of any material can be supplied. A weather-proof, gasketed cover protects the transmitter, no shelter is needed and it can be installed outdoors. It is fully described in Bulletin No. 43-4.

Wood Link Matting

THE DEVELOPMENT of substitute materials in the manufacturing of matting became a vital necessity when rubber and other materials were put on the critical list, if the safety, sanitation and comfort features of matting were to continue available.

The research staff of the American Mat Corporation, Toledo, Ohio, has recently developed Flexible Wood Link Matting which is substantially constructed of wood links. It is light in weight and can be rolled or folded up for easy handling and cleaning. Lying flat, it follows the contour of the floor.



Flexible Wood Link Matting makes for safety underfoot, is comfortable to stand on, and affords good drainage. The ends are beveled to reduce the danger of tripping. It comes in natural wood color and is inexpensively priced. The mat is 1 in. thick, and comes in stock sizes, 18 by 32 in., 24 by 38 in., and 30 by 44 in., but can also be obtained in special sizes of any length and up to 36 in. in width.

Flexible Wood Link Matting is particularly applicable for use in factories, around machinery, on oily and greasy floors.

Largest Seamless Welding Elbow

WHAT IS reported to be the world's largest seamless welding elbow is now in production at Tube Turns factory in Louisville, Ky. It is 30-in. in diameter and is to be used in sea-going drydocks

WAR CONDITIONS

DEMAND PACKINGS BE CONSERVED!

In the 50 years existence of this Company, never have Belmont Packings been in greater demand, more urgently needed.

Packings are important! They are essential not only in the production, but in the operation of guns and mobile equipment—tanks, planes, ships.

Materials used in the complete line of Belmont Packings come from far-off places—asbestos, flax, jute, rubber, lubricants. Supplies of these critical raw products have been restricted, by regulation, to war uses. In substance, demands and problems are great, the like of which the world has never seen before!

How can Belmont meet the situation? It must continue to work to capacity with tools available.

How can the user meet the situation? He can conserve the use of packings along the lines of the four suggestions below.

THE BELMONT PACKING & RUBBER CO. — BELMONT — PHILADELPHIA, U.S.A.

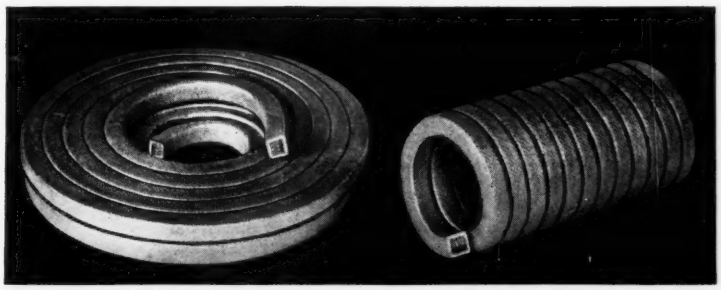
A—CONSERVE PACKINGS—When repacking, it may be found that a few rings of new packing inserted next to the gland may give added service. This will mean conservation of old packing retained in the stuffing box.

B—LUBRICATE MOVING PARTS—Keep rods, shafts and plungers thoroughly swabbed with oil or grease to alleviate frictional wear on packing. Where practicable, install oil lanterns.

C—CHOOSE SUBSTITUTE CONSTRUCTIONS—When material shortages make your desired type not instantly available, consult with your nearest Belmont distributor or with us for guidance on this question.

D—REFER TO THE BELMONT CATALOG—It's an invaluable packing guide of complete information on packings for all services . . . it contains informative charts; clearly illustrates and describes every Belmont packing; and suggests varied packing styles from which to choose a substitute packing, if necessary. Write on your Company letterhead for your copy.

There's a Belmont Packing for every service . . . Steam, Water, Oil, Gas, Air, Acid, Alkalis, and Ammonia. Forms include Rings, Coils, Spirals, Reels, Spools, Sheets, and Gaskets.



BELMONT PACKINGS

The Belmont Packing & Rubber Company

Butler and Sepviva Streets **Philadelphia, Penna.**

XUM

Just a drop of water-

harmless...

or is it?

Although specially treated for use in your water consuming equipment, it may still contain a sufficient amount of water hardness to cause boiler scale, priming, foaming, pitting or corrosion or caustic embrittlement.

There's no question about feed water conditioned by nature's own method discovered in the new TECHNICAL Water Conditioning System . . . a perfect balance of water's mineral content with correct, natural *organic substances.*

WATER CONDITIONING SYSTEM

TECHNICAL is a proven, natural system of individual formulas to fit each and every water type. It provides a special balance of water properties that definitely overcome scale, foaming, pitting, corrosion, priming, caustic embrittlement characteristic of boilers and condenser covering systems.

For your own satisfaction, investigate the new TECHNICAL System . . . Nature's own conditioning method developed under actual industrial operating conditions. Without obligation the coupon below will bring you the facts.

AMERICAN RADIATOR & Standard Sanitary
New York CORPORATION Pittsburgh

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Midwest Water Treatment Company, Cincinnati, Ohio

☐ Please send the new Technical System bulletin.
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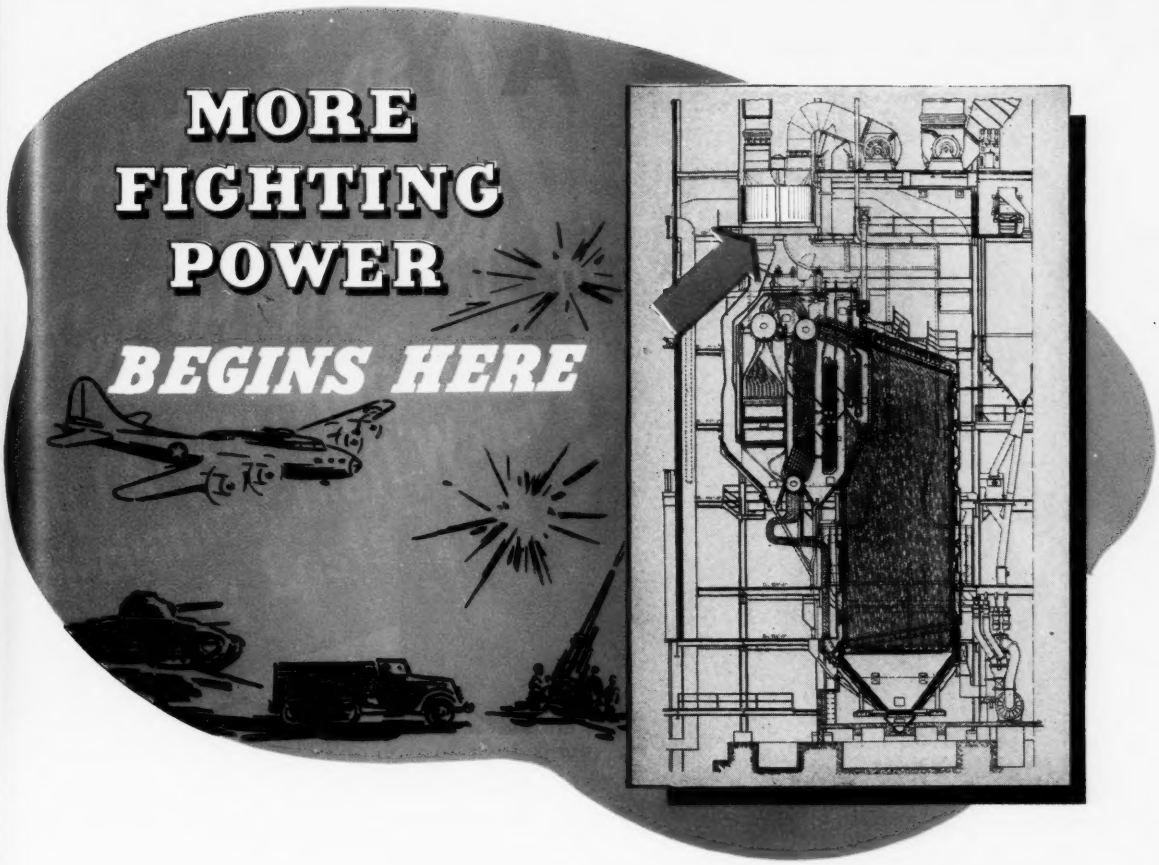
for the United States Navy. These are the largest seamless elbows ever made and, doubtless, these enormous drydocks are the largest floating structures ever known. Under their own power these dry docks will follow the fleet to battle areas where they will facilitate below-the-water-line repairs on all fighting ships and battle fleet-servicing ships. "Wounded" battleships, carriers, cruisers, submarines, destroyers . . . down to transports, supply ships and tankers will be saved which otherwise would sink before they could get back to a base.

A floating drydock is essentially a huge hollow platform that partly submerges, by letting water inside, until the ship to be serviced is floated above it. Then it rises, by pumping out the water from its hollow interior until the ship is no longer afloat. Batteries of large pumps will pump the water out—through the 30-in. welded pipe lines made with these huge elbows.

This 180 deg return can be used as such but in this instance will be cut apart into two 90 deg ells.

Vibratory Conveyors

FOR THE HANDLING of extremely hot materials, a new line of vibratory conveyor equipment in various styles and capacities has been developed by the Syntron Company, 494 Lexington Ave., Homer City, Pa. The conveyor action is accomplished by high speed vibration set up by multiple, pulsating driving magnets and requires no mechanical moving parts. Rate of flow of material through the conveyor is controlled by a rheostat from any desired position in the plant, or it can be arranged for automatic control.



Ljungstrom-equipped steam plants help meet power needs of America's No. 1 war-production area

THREE of these modern steam generating units, each rated at 440,000 lb. steam per hr., are now helping to meet vital power requirements of the Detroit area. Efficiency of powdered-coal firing is increased by preheated combustion air. Exit gas enters the Ljungstrom Preheaters at 780°, leaves at 353°, raising air temperature to 598 degrees.

• • • • •

Back of the bombers, back of the tanks and trucks and artillery now pouring out of our great production centers, is the "mechanical muscle" to build them – the power supplied by steam generating plants like these.

In the majority of cases, the largest, newest and most efficient boiler plants are equipped with Ljungstrom Air Preheaters. Three simple reasons explain why:

1. *Ljungstrom Air Preheaters save more fuel.* They increase the economic limit of heat recovery, improve the combustion conditions, and permit efficient firing of poorer coals.

2. *Ljungstrom Air Preheaters save steel.* The continuous regenerative counterflow principle results in ⅓ to ½ greater heat transfer per unit weight of heat-transfer surface. A lighter, more compact unit also saves steel in the supporting structure.

3. *Ljungstrom Air Preheaters sustain "high availability" records.* Operating records in many power plants show they are capable of long, continuous service under severe conditions, without interruption.

Application of Ljungstrom Air Preheaters is not limited to steam generating plants; they are being applied for heat recovery on oil heating furnaces, metallurgical furnaces and the like, where gas-to-air heat transfer is required. For complete information or engineering aid, write:

THE

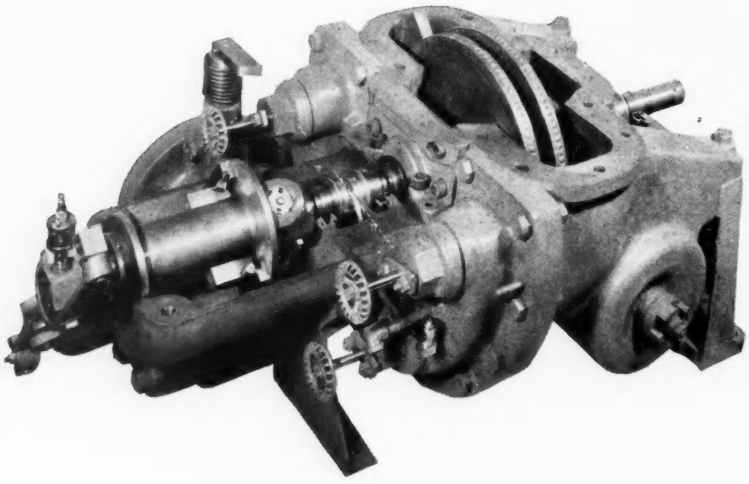
AIR PREHEATER

CORPORATION

Executive Offices: 60 East 42nd Street, New York, N. Y. • Plant: Wellsville, New York

MURRAY

Type "U" Mechanical Drive Turbines



★ Many of the advantages of the Murray Type "U" Mechanical Drive Turbine are illustrated in the accompanying internal view. The most outstanding feature is the arrangement of the casing, which as shown, is split horizontally well above the shaft center line. This unique and patented construction provides the following desirable features:

(1) Longer steam ring allowing considerably more nozzle area and larger steam inlet size, thereby increasing the maximum horsepower developed by a particular frame.

(2) Larger exhaust opening which permits of greater horsepower and improved efficiency, particularly for condensing operation.

(3) Additional hand valves for nozzle control. (Note that view shows three hand valves on our smallest frame, whereas the usual small conventional turbine has room for only one.)

Other desirable features shown are the stainless steel blading and shroud, center line exhaust end support, flexible steam end support, balanced governor assembly, precision bronze backed babbitt lined bearings, effective bronze labyrinth type oil seals which supplant the older felt type, and separate removable upper carbon packing gland cases.

BOILERS TURBINES ENGINES

MURRAY IRON WORKS COMPANY

INCORPORATED 1870

BURLINGTON IOWA

As shown in the illustration of a 35 ft section of a 130-ft long conveyor for handling extremely hot materials, the trough style may be of the flat type, or it may have sealed tubular sections with or without multiple intake openings or multiple discharge gates at various points.

Major advantages claimed for these conveyors are absence of abrasion, rheostat control of rate of flow and ability to handle extremely hot, abrasive materials. Designs are available for handling poisonous or dusty materials, or for keeping materials clean without exposure to dirty atmospheres or foreign materials.

Remote Electro-Hydraulic Transmitter

A NEW REMOTE CONTROL device combining the jet pipe principle with the functions of a Selsyn motor has just been announced by the Askania Regulator Co. of Chicago. The Selsyn movement merely operates the sensitive jet pipe, which, it is stated, is practically frictionless, and thus transmits the original impulse through a hydraulic system with sufficient power to operate heavy dampers, butterfly valves or any other equipment requiring accurate remote operation.

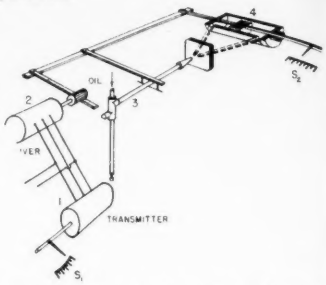


Fig. 1. Diagram showing how Selsyn actuates jet pipe to give remote hydraulic control

The diagram illustrates how the movement of the Selsyn transmitter 1 is transmitted to the receiver 2 which in turn alters the position of the jet pipe 3, causing a greater hydraulic pressure to result on either side of piston 4. Amount of movement of the piston is always pro-

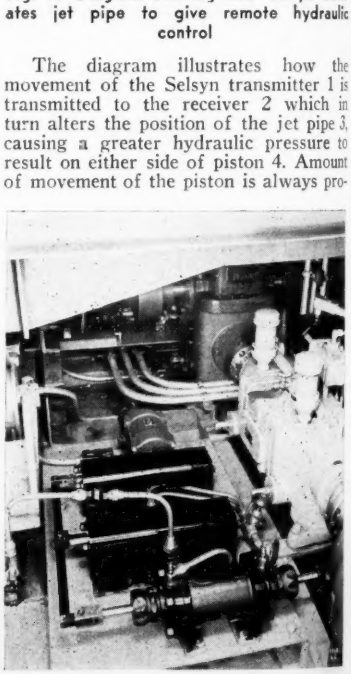
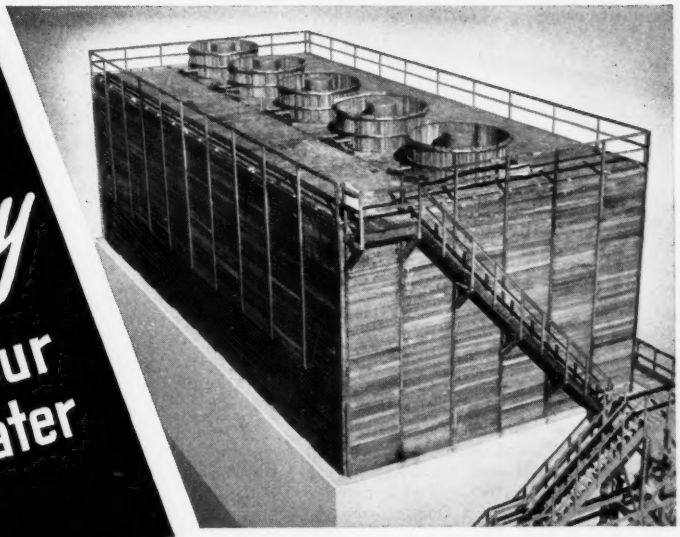


Fig. 2. View of hydraulically driven worm gear with speed control by electro-hydraulic transmitter

How to Save a Lot of Money

By CAPITALIZING Your Mechanical Draft Water Cooling Costs



A mechanical draft cooling tower is, in most cases, a means of saving money. The cost of that tower, erected and ready for service, plus the cost per year to operate it, are therefore completely tied up together. To know just where you will stand in five years, both first cost and operating cost should be figured *when the tower is bought.* That is cost capitalization.

Pritchard mechanical draft towers almost invariably show a saving when competition is on this basis. The reasons why are discussed in the column at the right. This saving usually is substantial enough to make any reasonable first cost acceptable.

That is why it will pay you to get cost capitalization figures from Pritchard—and from all other bidders—before you buy any mechanical draft cooling tower. Write today.

THESE IMPORTANT FACTORS Reduce Pritchard Mechanical Draft Operating Costs

1. High Efficiency, Light Weight, Non-Corrosive Monel Fans. Pritchard fans are the heart of Pritchard tower efficiency and economy. Their superior design and construction saves tremendous amounts of horse power over a period of years. Blades have a special twist and taper that gives a steady, uniform air flow through the entire fan opening.

The use of non-corrosive sheet monel over a light, strong framework cuts weight to half that of cast alloy — ends corrosion and pitting troubles. Larger blades, and often fewer of them, move the required volume of air with less fan speed and less fan power. Pritchard fan drive design and fan housing design, particularly in induced draft towers, contribute further to fan efficiency and horsepower economy.

2. Low Pumping Head. Closed pipe water distribution through gravity sprinklers cuts down frictional resistance; saves pump power for lifting; sometimes even permits building higher towers without waste.

3. Liberal Size and Rating. Any "skimping" on capacity must be made up by an extra load on fans or tower efficiency will suffer. Pritchard towers are sized and rated to permit low air velocities and consequent lighter fan loads.

Further details on request. Write for them.

J. F. PRITCHARD & COMPANY
FIDELITY BUILDING **KANSAS CITY, MO.**

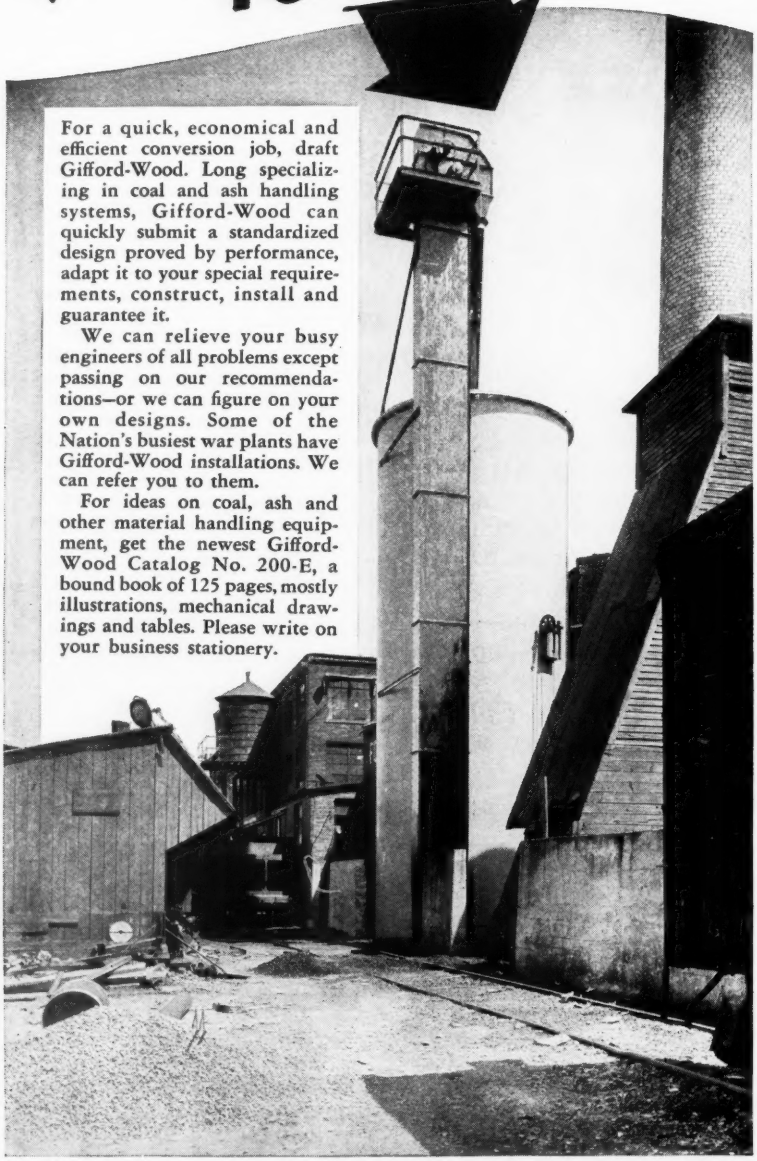
• Branch Offices in Tulsa, Okla.; Houston, Texas; Atlanta, Ga.; Chicago, Ill.. Pittsburgh, Pa.; New York City

PRITCHARD

Atmospheric and Mechanical Draft

WATER COOLING TOWERS

Speedy Conversion TO COAL



For a quick, economical and efficient conversion job, draft Gifford-Wood. Long specializing in coal and ash handling systems, Gifford-Wood can quickly submit a standardized design proved by performance, adapt it to your special requirements, construct, install and guarantee it.

We can relieve your busy engineers of all problems except passing on our recommendations—or we can figure on your own designs. Some of the Nation's busiest war plants have Gifford-Wood installations. We can refer you to them.

For ideas on coal, ash and other material handling equipment, get the newest Gifford-Wood Catalog No. 200-E, a bound book of 125 pages, mostly illustrations, mechanical drawings and tables. Please write on your business stationery.

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Ash Spouts • Barge Unloading • Bins • Boiler House Equipment • Buckets • Bunkers • Carriers • Chutes
Conveyors • Crushers • Elevators • Feeders • Gates • Ground Storage Systems • Hoists • Hoppers
Infra-Red Drying Systems • Screens • Silo Storage Plants • Tanks • Weigh Larries

3685

portional to the amount of the original Selsyn motor movement.

The cylinder can be used to produce a proportional stroke, force or rate of turn proportional to the displacement of transmitter Selsyn 1.

The factor of power, force or amplification is practically unlimited and accuracies of 0.2 per cent is obtained; greater accuracies can be provided when required.

Dual-Vane Pumps

ANNOUNCEMENT is made by Hydra-Motive Division, Detroit, Mich., that three new constant delivery, hydraulic (oil) vane type pumps designed especially for high pressure operation are now available in three sizes to give from 2½ to 60 gpm. The new pumps are of the dual vane design which permits operation under high pressures without overheating, with reduction in wear and also allows the pumps to withstand line surge without damage. The pumps also incorporate the new "compound pumping" development which increases the capacity of the pump by as much as 30 per cent without increase in the overall size of the housing.

The maximum continuous operating pressure of the standard pumps is 1250 psi, but the pumps are also available for operation at considerably high pressures. Pressures as high as 2000 psi can be handled by the pumps for prolonged periods without damage or overheating.

The use of Dual Vanes counterbalance the total outward pressure on the vanes and prevents overheating and wear even at excessively high pressures. Instead of a single vane in each vane slot, two vanes are used. Each of these is ground with a bevel so that oil under full operating pressure can reach the outward edge of each pair of vanes. This back or counterbalancing pressure can be varied by changing the angle at which the vanes are ground so that the vanes are held against the stator with only the necessary amount of pressure to effect an adequate seal.

Mobil Purifier

HONAN-CRANE CORPORATION of Lebanon, Ind., has a new portable truck-mounted assembly for its oil-conditioning equipment which combines the purifier unit to remove moisture, acidity, and oxidation and a filter press to remove foreign solid matter from insulating oil.

engine efficiency down?

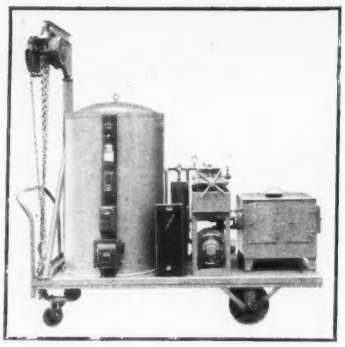
*check your exhaust piping**

* Loss of engine efficiency, excessive back pressure, unnecessarily noisy operation, can often be traced directly to improper exhaust piping. It will pay you to check with the Maxim Engineering Dept. Whether or not you have or can buy silencers today, Maxim's wartime engineering service is yours for the asking. Simply give full details and write to The Maxim Silencer Co., 89 Homestead Ave., Hartford, Connecticut.

Maxim Waste Heat Units save fuel. Bulletins WH-100 and WH-103 on request.

MAXIM

WARTIME ENGINEERING SERVICE



Purifier and filter are assembled with a motor-driven rotary pump, the necessary piping, an air separator to remove entrained air from the oil and an electric oven to dry out the filter paper for the press prior to placing it between the plates. The piping is arranged so the pump can serve either the purifier or the filter, or both, or serve only to circulate the oil.

In use, the equipment is brought to position near a piece of equipment containing oil to be conditioned and the suction side of the pump is connected by suitable means to draw the oil in. There are three sizes in the line with capacity of 100 to 300 gph. A crane at one end serves to remove the cover of the purifying unit and to assist in handling the replace elements.

"TAILOR-MADE" FIREBRICK
This New Circular Tells How
These Days are Gone Forever
Shorter lengths, and special angles can all be made quickly and accurately on your job from virtually any firebrick.
Clipper Masonry Saws are rapidly gaining popularity with power plants because of their ability to speed repairs and lessen "Down Time."
You can easily and economically cut Clay—Chrome — Silica — Magnesite — Sillimanite and Acid Brick.
Get this latest information by writing . . . today.
CLIPPER MFG. COMPANY
Suite 4, Chouteau Building
St. Louis, Missouri

OBITUARIES

Joseph W. Hays

JOSEPH WELLER HAYS, the first man to be known as a "combustion engineer" and founder of what is now The Hays Corp., died at the family home in Grinnell, Iowa, April 22, 1943, at the age of 75.

Probably no man in America was so well known to boiler room operators and thousands of others in Industry as Joe Hays. A practical operating engineer, consultant, writer, lecturer, inventor, teacher, he touched intimately the lives of thousands working to obtain better combustion conditions in the steam plants of the nation. His book, "How to Build Up Furnace Efficiency" now in its 18th edition with a distribution of over 125,000 copies, is the boiler room crews' operating bible and will perpetuate the name and knowledge of Joseph W. Hays for generations to come.

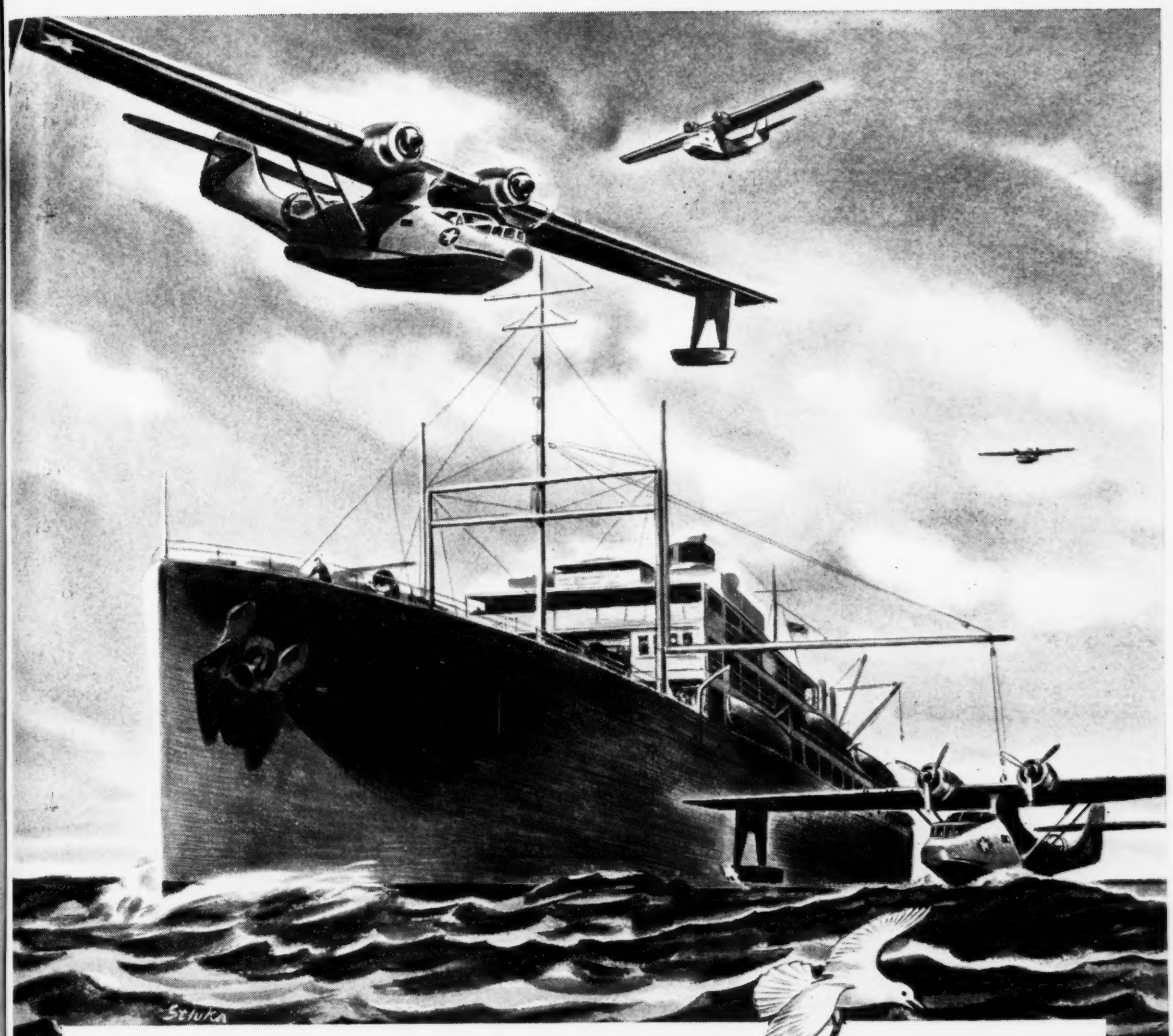
Born in Chester Township, Poweshiek County, Iowa, November 12, 1868, Joe attended the nearby country school and later Grinnell College Academy and Cornell College at Mt. Vernon, Iowa, from which he was graduated with a literary degree in 1890. He intended to make Journalism his life work, but a visit to the World's Columbian Exposition at Chicago in 1893 changed his mind.

The smoke that enveloped the city looked like a preventable waste to Mr. Hays. He turned up the "Provident Smokeless Furnace" and assumed the sales agency for it. He took an absorbing interest in smoke abatement and combustion efficiency, and produced fuel savers and waste detectors in many forms. Among the first was an improved portable flue gas analyzer or Orsat. Later came a CO_2 recorder for which Mr. Hays and his brother, Charles, were awarded a Certificate of Merit by the Franklin Institute of Philadelphia.

In 1918 Mr. Hays moved from Chicago to Michigan City where he conducted an instrument business besides acting as consultant on combustion problems. In 1925 he sold out the manufacturing end of the business to Phil T. Sprague who had been selling instruments for him. At this time the name of the business was changed from The Joseph W. Hays Corp. to The Hays Corp.

Arthur G. Shelley

ARTHUR G. SHELLEY, Washington representative of Combustion Engineering Co., died on April 28, 1943, after an illness of several months. Mr. Shelley became associated with the company in 1933 following 22 years' experience in the erection, operation and sale of stokers for two large stoker manufacturers. Mr. Shelley had been located in the Washington, D. C., office since 1940 where he had devoted most of his attention to negotiations for stationary equipment.



Eyes and Ears of the Fleet

You hear more of other craft than of Seaplane Tenders — but from Pearl Harbor on they've been in there . . . patrolling . . . listening . . . *fighting*. A Jap fleet moves toward the Solomons. Long before it is within range of land-based aircraft, Seaplanes from a Seaplane Tender have spotted it. From then on the officers of America's fighting forces know every move of the enemy, and what to do about it, for example, the Bismarck Sea!

To provide both propulsion and auxiliary Diesel engines for these and other important warcraft of the U. S. Navy is the assigned task of Fairbanks-Morse. It is a task of which we are proud. We feel that nothing less than our level best is good enough.

Fairbanks-Morse & Co., 600 South Michigan Avenue, Chicago, Illinois.

FAIRBANKS, MORSE & CO.

XUM

The
ENEMY
of
- SCALE
- SLIME
- RUST
- DIRT
- ALGAE

• **SOL-VET "08"** is a fast, efficient cleaner of all equipment using water for cooling. By dissolving impurities *completely*, they are carried out *in solution*, thus preventing clogging. Head pressures fall to normal; heat transfer is raised to maximum; full circulation is restored; life of equipment prolonged. On large jobs, shutdown time is cut to a maximum of 6 to 8 hours.

GUARANTEED EFFECTIVE
If you find SOL-VET "08" is not exactly as represented, when used according to instructions and full, accurate report is given within 30 days from date of purchase, your money will be *refunded in full.*

GUARANTEED HARMLESS
when used as directed, to all water conducting materials used in water cooled equipment.

WRITE TODAY
for complete data and analysis and recommendations for your specific problem.

SOL-VET "08"
Water Treatment Formula
MANUFACTURED and GUARANTEED by
ANDERSON-STOLZ CORPORATION
1733 WALNUT STREET • • • KANSAS CITY, MISSOURI

ALLPAX
THE PACKING THAT "PACKS ALL"
. . . use it once and
. . . you'll use it always

THE ALLPAX CO., INC.
Mamaroneck, N. Y.
•
Distributors Everywhere

Here's the universal packing that can be used for any fluid or on any apparatus—economically, efficiently—tightly—simply.

Try ALLPAX and you, too, will be enthusiastic over its easy application and long wear. You don't have to remove old packing to repack with ALLPAX. Square cross section makes ALLPAX easy-filling in any stuffing box.

Try it and you'll always use it. Full details on request.

J. Milton Goff

J. MILTON GOFF, President and director of E. M. Dart Mfg. Co., of Providence, R. I. died at his home at Cranston, R. I., April 29, 1943. In addition to being president of E. M. Dart Mfg. Co., Mr. Goff was secretary and director of Dart Union Co., Ltd., Toronto, Ont., Canada; director and member of the executive committee, United Wire and Supply Corp., Cranston, R. I.; trustee, Hall Library, Cranston, R. I.; and president, Goff Gathering Assn, Rehobeth, Mass. He is survived by his widow, Gertrude R. Goff, his son, Milton L. Goff, two grandchildren and one sister. Mr. Dart was born in Providence, R. I., September 9, 1875.

John T. McTarnahan

JOHN T. MCTARNAHAN, president of the La Mont Steam Generator Co., the La Mont Licensing, Inc., and Steam Power, Inc., died April 29 at his home in Larchmont, N. Y. He was 59 years old.

A native of Mono County, Calif., Mr. McTarnahan was considered a pioneer in American aviation. In 1910 he designed several pusher biplanes and in 1912 accompanied Roy Francis on the first flight across San Francisco Bay. He served in the U. S. Navy during the Spanish-American War.

Albert L. Austin

ALBERT L. AUSTIN, Sales Engineer of Robins Conveyors Incorporated, Passaic, N. J., died Sunday, May 2, after a long illness. Mr. Austin had been with Robins Conveyors Incorporated since 1934 when he became a Sales Engineer covering an extensive Eastern and Southern territory on projects of a specialized nature.

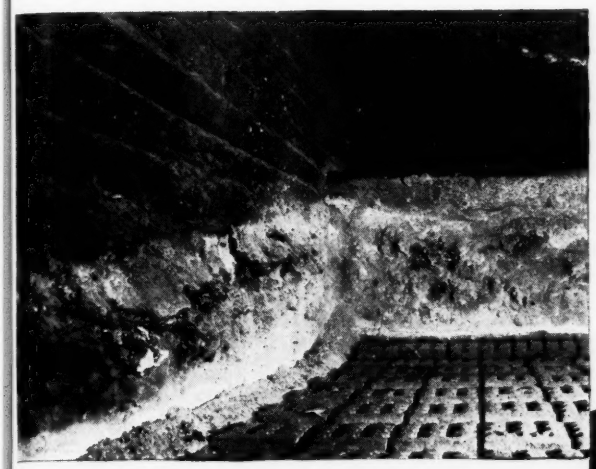
MANUFACTURERS' PERSONALS

Roy M. Smith who joined the Roller-Smith Co., Bethlehem, Penna., in August, 1942, as assistant chief engineer has been appointed chief engineer, succeeding J. D. Wood, resigned. Mr. Smith came to Roller-Smith from the Bryant Electric Co., where he was engineering manager for the Wiring Device Division. Prior to this, he was with the Westinghouse Electric and Manufacturing Co. as section engineer on relay design and application. Graduated from the University of Washington, Mr. Smith has been active in the American Institute of Electrical Engineers for a number of years. He also is the author of several articles which have been published in leading magazines serving the electrical industry.

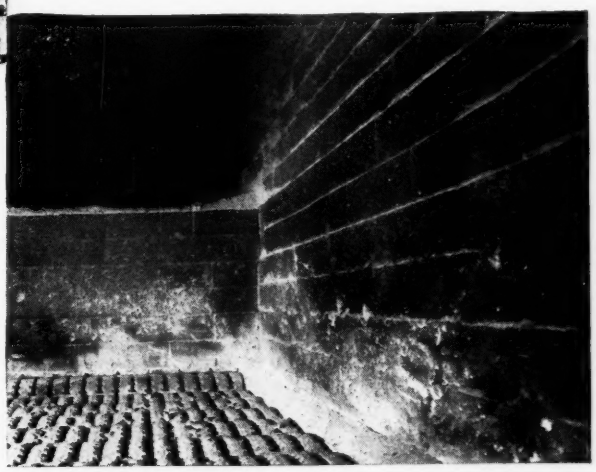
Earl S. Patch has been appointed sales manager, by Henry L. Crowley & Co., Inc., West Orange, N. J., manufacturers of the Crolite line of steatite, high-frequency iron cores, and powder-metal parts and bearings. Formerly an executive of the Moraine Products Division of General Motors in Dayton, Patch is considered an authority in the field of powder metallurgy with a background of research, engineering, production and application experience which he now brings to bear on the design and fabrication problems of many industries. He will make his headquarters in the company's main office.

CRYSTOLON BRICK [Silicon Carbide]

Make the Big difference-



(Left) Ordinary brick after a period of approximately three years in one of a pair of heating boilers are obviously in poor condition. A troublesome "shutdown" will be necessary.



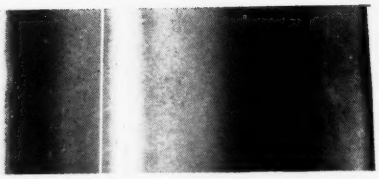
(Right) *Crystolon* Brick after the same period of service in the other boiler are still in excellent condition. They will give many more years of uninterrupted service.

Crystolon Brick are particularly resistant to high temperatures and to the chemical action of molten slag. Because of exceptional density they resist the penetration of molten ash. Ruggedness enables *Crystolon* Brick to resist the abrasive action of ash and the motion of the fire bed in stoker-fired furnaces.

Crystolon is the Norton registered trade mark for silicon carbide and silicon carbide products.

NORTON COMPANY—Worcester, Massachusetts

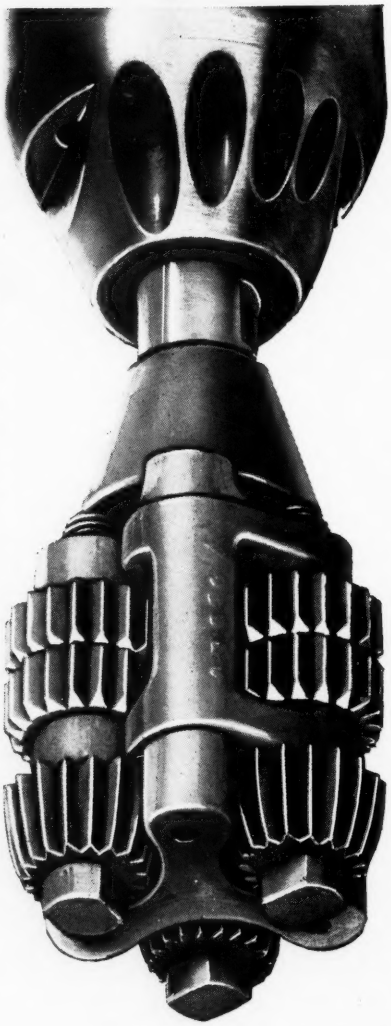
NORTON ELECTRIC FURNACE FUSED REFRACTORIES



Power and Manpower

ROTO

Tube Cleaners Give You Both



Anything that saves manpower today is of prime importance. Every Roto Tube Cleaner equipped with an air valve on the motor releases one helper for other duties. Since the operator himself controls the entire operation of the cleaner, he does not need a helper to turn air off and on every time he removes the cleaner from one tube to another. This not only saves the helper, but also saves time ordinarily lost by signalling between operator and helper.

A Roto Tube Cleaner provides you with a streamlined, concentrated package of power that removes the hardest scale or gummy deposits with a thoroughness and speed that will restore your equipment to top efficiency hours sooner than with old type cleaners. That's the kind of tube cleaner you need today. Write for details.

The **ROTO** Company

145 Sussex Ave., Newark, N. J.

CHANGE OF ADDRESS

To avoid missing an issue or paying for forwarding postage be sure to send a change of address to our office. Changes received by the 20th of the month can be made effective for following month's issue.

POWER PLANT ENGINEERING

Robert C. Allen has been made manager of Allis-Chalmers steam turbine department, succeeding the late Arthur C. Flory, according to an announcement by the company's president, Walter Geist. As assistant manager, Mr. Allen had been supervising this department's operations since illness made it necessary for Mr. Flory to relinquish his duties several months ago.

Mr. Allen came to Milwaukee in 1931 as manager of engineering at the A. O. Smith Corp. He became chief engineer there 2 yr. later. He left Milwaukee in 1934 and was chief engineer for the Murray Iron Works at Burlington, Iowa, until 1936.

Joining the Allis-Chalmers organization in 1936, Mr. Allen became the steam turbine department's chief engineer in January of 1942, taking charge of steam and gas turbine design, development, field work and testing. This now includes the company's turbo-supercharger program. In June, 1942, he was given the additional title of assistant manager.

Al Campbell, formerly of Manning, Maxwell & Moore, Inc., of Bridgeport, Conn., has become associated as sales manager with Kieley & Mueller, Inc., of North Bergen, N. J., manufacturers of Engineered Pressure and Fluid Control Specialties.

Greene, Tweed & Co., New York City, manufacturers of Palmetto and other mechanical packings, Basa Soft-Face Hammers and Favorite Reversible Ratchet Wrenches, announces the appointment of J. J. McIntosh as South-Eastern Sales Representative and B. F. Coombs as Texas Sales Representative.

Charles R. Cox has been elected president of the National Tube Co. and of Tubular Alloy Steel Corp. Mr. Cox, who for the past two years has been executive vice president of National Tube Co., will succeed Benjamin F. Harris, who recently resigned. Mr. Harris is now a consultant to Mr. Fairless in connection with war activities. Coming to the National Tube Company from his position as superintendent of Babcock & Wilcox Tube Co., Beaver Falls, Pa., in 1934, Mr. Cox was employed at the Ellwood Works, Ellwood City, Pa., where he soon became general superintendent of the plant. In 1936, he was appointed vice president in charge of operations, National Tube Co., with offices in Pittsburgh.

A. E. Bedell has been appointed Chief Engineer of Graver Tank & Mfg. Co., Inc., in charge of all engineering and development covering all divisions of the company, with headquarters at the general offices of the company located at East Chicago, Indiana.

Mr. Bedell was formerly associated with Max B. Miller & Co., Inc., and for 14 years was in charge of engineering for that company. His experience includes construction of refinery equipment, supplemented by previous experience in the chemical, power, sugar, and general industrial fields.

IN DESUPERHEATING SERVICE . . .

"THIS PUMP HOLDS TEMPERATURES WITHIN ±1° F."

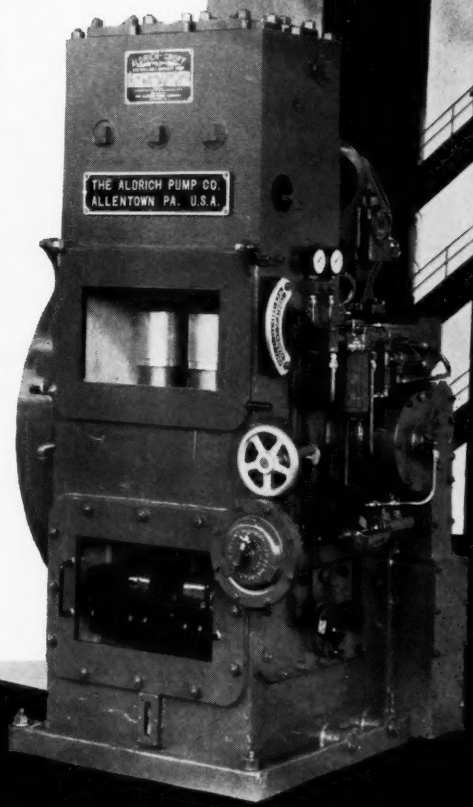
UNDER FULLY AUTOMATIC CONTROL

In an eastern public utility station, an Aldrich-Groff controllable capacity "Powr-Savr" Pump has been in almost continuous operation for nearly three years, supplying water for desuperheating steam. Arranged for automatic temperature control, its response is such that "the indicating and recording instruments show a total variation of only 1° F. from the desired temperature". This pump has a variable capacity from 0 to 65 GPM at a constant pump speed of 190 RPM against 350 lbs. pressure and is driven by a 20 HP 1750 RPM constant speed A.C. motor.

Aldrich-Groff Pumps provide for automatic or remote manual control of delivery from zero to full rated capacity at constant pump speed. Rate of delivery is controlled by variation of the length of plunger stroke and power consumption is almost directly proportional to pump delivery. They offer the advantages of feed system simplicity, efficiency and mechanical reliability of the small and medium boiler plant using medium or high steam pressures, and for desuperheater feed service in even the largest power stations.

Write for bulletins and material giving full details, sizes and ratings of Aldrich-Groff Pumps.

THE ALDRICH PUMP COMPANY
ALLENTOWN · PENNA.



THE ALDRICH-GROFF CONTROLLABLE CAPACITY "POWR-SAVR" PUMP
TRADE MARK

AMONG THE THINGS YOU'LL LIKE ABOUT

CHESTERTON

Parachute Packing

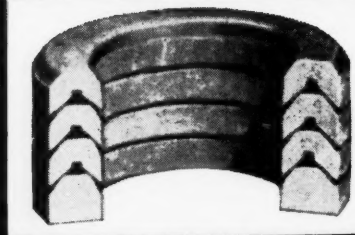
NO BOTHERSOME AFTER-ADJUSTMENTS

In filling an order for a set of Chesterton Parachute Packings, we take into account the depth of the stuffing box, the distance the gland enters the box, and the fluid pressure. These data enable us to provide a packing *tailor-made* to suit predetermined expansion—a truly automatic packing.

Engineers and master mechanics are enthusiastic about this big Chesterton advantage. It means they will not need to waste time and energy "backing off" the gland to relieve excessive self-generated pressure. No after-adjustments greatly simplifies maintenance of rams, accumulators and other hydraulic equipment.

Chesterton Parachute Packings are sold in all principal cities by *Factory-Trained* Distributors. Write for Catalog 20-E which describes complete line; includes helpful Packing-Selector chart.

for
STEAM · WATER
AIR · GAS · HOT or
COLD OILS · SOLVENTS



A. W. CHESTERTON CO.
64 INDIA STREET, BOSTON, MASS.
Factories: Melrose, Mass.—Chicago, Ill.

WHEN YOU WRITE TO ADVERTISERS

When writing advertisers for catalogs, descriptive bulletins or prices, please remember to say, "I saw your message in POWER PLANT ENGINEERING." Thus you'll do a good turn for the advertiser and for this publication. . . .

Grant B. Shipley has been elected chairman of the board of directors of the Elliott Company, according to an announcement made by Howard M. Hubbard, president of the Company.

Mr. Shipley's experience in the industrial field started in the shop as a mechanic, then as draftsman, designer, construction engineer, chief engineer, sales engineer, and manager. He organized several substantial enterprises, of which he was president and chairman. As an engineer he has been connected with shipbuilding, mining, wood preserving and power plant equipment.

Mr. Shipley is a director of both The International Nickel Co., Inc., and The International Nickel Co. of Canada, Limited, and a member of the latter's executive committee, consultant to Koppers Co. and others.

F. J. Healy, formerly vice president in charge of the lighting division, has been appointed vice president in charge of operations, as announced by Walter E. Poor, president of Sylvania Electric Products Incorporated. Mr. Healy joined the company in 1918 as a floor boy and worked up through various departments to his present position. In his new post he will be responsible for all manufacturing operations in both the lighting and radio tube divisions of the corporation.

Chester F. Horne, formerly manager of operations at the fixture and appliance plants in Massachusetts, has been appointed general manager of the lighting division, replacing Mr. Healy. Mr. Horne has been with the company since 1920 and in his new position will be responsible for all manufacturing activities at the company's lamp, fixture, appliance and fluorescent powder plants in New England and Pennsylvania.

Frank H. Robb has been appointed manager of the Manufacturing and Repair Department of Westinghouse Elec. & Mfg. Co. for the Los Angeles area as announced by Harry F. Boe, Vice President in charge of the Company's District Manufacturing and Repair Department. Mr. Robb succeeds Charles G. Yarbrough who has retired after 47 years' service with the company.

Mr. Robb joined the Westinghouse organization in 1919 as service engineer in the Automotive Division at Pittsburgh and in 1924 was transferred to Springfield, Mass., as superintendent of the Automotive Service Department. In 1926 he was made supervisor of the Service Sales Department in Boston and in 1934 was named manager of the Manufacturing and Repair Department at Springfield, a position which he held until his transfer to the West Coast.

Charles A. Butcher, formerly assistant to the national manager of Westinghouse Elec. & Mfg. Co.'s District Manufacturing and Repair Department, has been named manager of that department for the entire Pacific Coast District of Westinghouse. Mr. Butcher will succeed R. E. Powers, who has resigned.

How to make your old Valves "Good as New" —Quickly . . . Easily . . . at Low Cost

USE

DEXTER

VALVE RESEATING EQUIPMENT

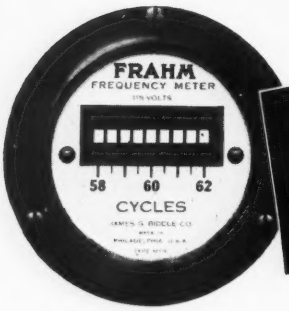
When a valve *starts* to leak . . . you can fix it right away — on the line — with Dexter Valve Reseating Equipment. No delays, no production upsets.

Even when a valve has been allowed to reach a "junked" condition, it can often be brought back to life with Dexter Valve Reseating Equipment . . . made to give "good as new" performance again. And it doesn't take long to make a valve seat and disc or gate *absolutely tight* again.

Dexter Equipment is equally efficient with *all* makes and types of valves because there are Dexter Cutters for monel, stainless steel, stellite, bronze and brass. Send for further information about Dexter Equipment today.

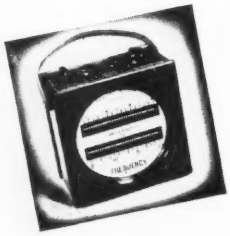
DEXTER
Valve Reseating Equipment
THE LEAVITT MACHINE COMPANY
406 EAST RIVER STREET, EAST ORANGE, MASS.

CAPACITIES: *Globe valves, ¼" to 14"; Gate valves, 1½" to 48"; Pump valves, 1½" to 15".*



A MINIATURE FREQUENCY METER THAT IS RELIABLE!

This Miniature Frahm Vibrating-Reed Frequency Meter (shown actual size above) is an indicating instrument without moving system or pointer. The operating principle and the method of indication are based on resonant vibration of accurately tuned steel reeds. These instruments are easy to read, ruggedly constructed, surprisingly accurate over long periods of time and are unaffected by wave form or by ordinary changes in voltage and temperature. Available in various ranges of power frequencies from 15 to 500 cycles per second; in fact, the same instrument can have more than one range.



"Frahm" Portable type Frequency Meter. Mounted in polished walnut case 9¼" x 8½" x 4½" overall, with carrying handle. Wide range, such as 22.5 to 90 cycles per second. Arranged for various potentials from 50 to 300 volts.

Write for illustrated Bulletin 1695-PE describing types shown.

JAMES G. BIDDLE CO. • 1211-13 ARCH STREET PHILADELPHIA, PENNA.

UNRETOUCHED PHOTOGRAPH OF

SCALE DEPOSIT IN 12-INCH STEAM LINE

WE READ WATER

Scale deposits in pipes such as pictured here cost your plant far more than the small amount you would pay for water treatment.

Haering Glucosates quickly and surely remove this scale and prevent further deposits as well as protect the pipes from corrosion.

Call in a Haering engineer, without obligation, for consultation; or write for our new booklet "Water Studies".

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D. W. Haering & Co., Inc.
205 Wacker Drive, Chicago.

Please send me information on Steam Treatment. (P.P.E.)

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City ..... State .....

MANUFACTURERS' NEWS

Army-Navy "E" Awards

Ampco Metal, Inc.
Milwaukee, Wisc.
The Babcock & Wilcox Co.*
Barberton Works
Electric Storage Battery Co.*
Philadelphia, Pa.
Hammond Brass Works
Hammond, Ind.
Ladish Drop Forge Co.
Cudahy, Wis.
Manning, Maxwell & Moore, Inc.
Boston and Bridgeport Works
Moore Steam Turbine Div., Worthington Pump & Machinery Corp.
Wellsville, N. Y.
Owens-Corning Fiberglas Corp.*
Newark, O., and Ashton, R. I., plants
Philco Corp.*
Chicago Plant and Storage Battery Div., Trenton, N. J.
Sarco Co., Inc.
Bethlehem, Pa., Plant
The Union Metal Mfg. Co.
Canton, Ohio
Ware Brothers, Div. of Chicago Roller Skate Co.
Chicago, Ill.
Westinghouse Elec. & Mfg. Co.*
District Mfg. and Repair Plant, Newark, N. J.

Maritime Commission "M" Award

The Babcock & Wilcox Co.
Barberton Works
Trill Indicator Co.
Corry, Pa., Plant

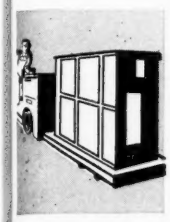
*Added star for sustained high achievement in production of war equipment.

R. E. Chase & Co., with headquarters in the Tacoma Building, Tacoma, Wash., and branch offices in Seattle, Spokane and Portland have been appointed by Elgin Softener Corp., Elgin, Ill., as district representatives in the northwest territory. They will handle both the Elgin industrial and marine line of water conditioning products.

Approval of the organization of a new Anthracite Stoker Manufacturers' section was recently announced by J. M. McClintock, president of the Stoker Manufacturers' Association, Chicago, Ill. The section will devote its time and attention to problems and subjects involving anthracite stoker equipment. Eight exclusive stoker manufacturers located in the Eastern states are affiliated with the association.

The Johnston & Jennings Company, 864 Addison Road, Cleveland, Ohio, widely known manufacturer of Oceco tank fittings and Stowe industrial stokers, has purchased the exclusive manufacturing and sales rights of Rusta-Restor—a cathodic (i.e. electrical) process for preventing rusting of water tanks, piping and similar steel structures, which has been tested and approved by the American Water Works Association, Factory Mutual, and other Laboratories and is said to have won highest commendation from users in both the municipal and industrial fields.

This CONSERVATION PLAN *will help you* SAVE MAN-HOURS... SAVE MATERIALS...SPEED PRODUCTION

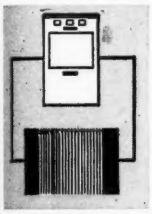


1. Conserve

by strategic selection, application and use of electrical equipment.

EXAMPLE

"Factory-packaged" equipment saves installation time and materials. An illustration of this is the Westinghouse "Power Center" which combines all transformer and switching equipment into one ready-to-use unit.



2. Conserve

by utilizing new developments that reduce need for critical materials and man-hours.

EXAMPLE

High-frequency heating reduces, by as much as 95%, the curing time required for producing thick plywood, plastics and other nonmetallic substances.

5. Conserve

by tapping all sources of salvageable scrap.

EXAMPLE

Systematic planning can uncover many ways of reclaiming worn equipment and waste material. Samples of salvage forms and organization charts in use in Westinghouse plants will gladly be made available on request.

3. Conserve

by utilizing available facilities for preventing breakdowns and reducing machine outages.

EXAMPLE

"Maintenance Hints"—a complete, pocket-size manual covering recommended upkeep practice for electrical apparatus—is a maintenance help available without charge. Check your Westinghouse representative for copies.

4. Conserve

by utilizing materials which in many cases can replace critical materials and do a better job.

EXAMPLE

Phos-Copper brazing alloy is easing bottlenecks created by a shortage of tin solders for joining metals. In some cases, one pound of Phos-Copper eliminates the need for as much as 12 pounds of tin.

Wartime Conservation means MORE than just conserving copper, steel, aluminum . . . it means the most strategic possible use of all of the ingredients of Victory—materials, man power, time and ingenuity.

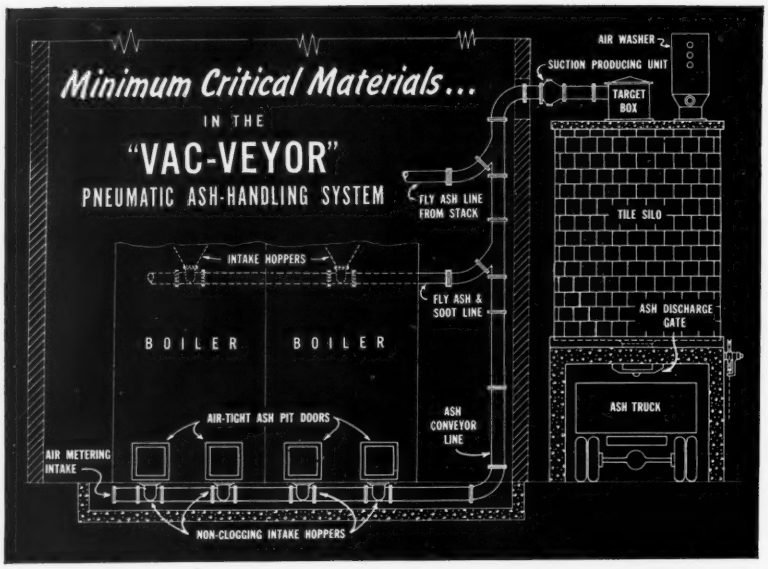
These five major points comprise a complete program developed by Westinghouse for Wartime Conservation. This program packages up Westinghouse engineering experience in the entire field of electric and power equipment and related materials. Examples noted are but five of many specific recommendations.

This experience and these recommendations are offered fully and without obligation.

Ask your Westinghouse representative today for a copy of the new 100-page book, "WARTIME CONSERVATION." Or write direct to Dept. 7-N, Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa. J-90482

Westinghouse

PLANTS IN 25 CITIES... OFFICES EVERYWHERE



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Designed to fill today's needs in either new installations or oil-coal conversion, this pneumatic ash handling system offers numerous advantages.

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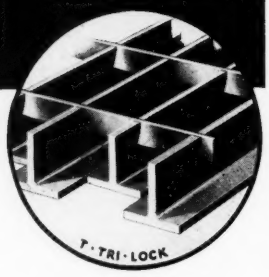
MANUFACTURERS AND ERECTORS OF COMPLETE COAL AND ASH HANDLING SYSTEMS

Specify
TRI-LOK

Full descriptive catalog of Tri-lok Grating, Safety Treads and other products on request.

OPEN STEEL FLOORING • SAFETY STEPS
CONCRETE ARMORING T. TRI-LOK



DRAVO CORPORATION
300 PENN AVENUE, PITTSBURGH, PA.
REPRESENTATIVES IN PRINCIPAL CITIES

Schwarze Electric Co. announces a large expansion program at its plant at Adrian, Michigan, due to the extensive development of the use of audible electrical signaling systems. Originally used chiefly for the streamlining of industrial production, the varied lines of horns, bells and buzzers made by the company are now being used in combat and commercial aircraft, naval and merchant marine shipping, and in practically every spot where coding and calling is done by sound.

Three new additions to personnel are also announced. Paul H. Hill has been appointed sales manager, Charles H. Brown assistant sales manager and advertising manager, and M. I. Bradley production manager. Additions have also been made to the engineering staff both in designing and production.

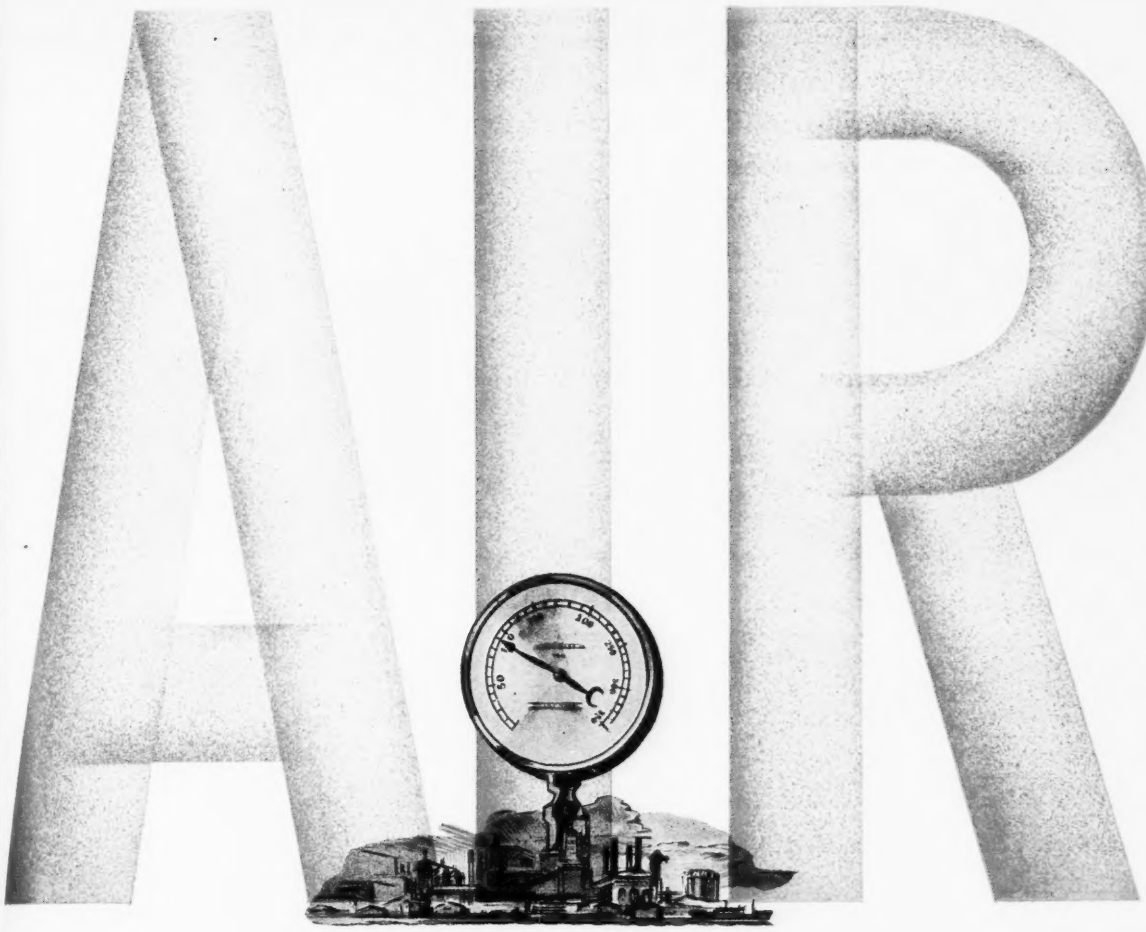
Meehanite Metal Corp. and the Meehanite Research Institute of America, Inc. announce the moving of their headquarters from Pittsburgh, Pa., to Pershing Building, New Rochelle, N. Y. The new headquarters will feature enlarged laboratory and research facilities, and will permit the rendering of improved service to industrial users of Meehanite Castings and the members of the Meehanite Research Institute.

Formica Insulating Co. at its recent annual meeting named five additional vice presidents. According to D. J. O'Connor, president, the move was made because of the rapidly rising volume of business and to plan for postwar developments. The meeting was held at Cincinnati, O.

Philco Corp. by agreement with American Steel Export Company, Inc. has formed the Philco International Corp. with offices at 230 Park avenue, New York, N. Y., to handle sales of Philco products in all countries outside the United States. Officers of Philco International Corp. will include Larry E. Gubb, Chairman of the Board of Directors; Dempster McIntosh, New York City, President; John S. Haber, New York City, Vice President; and William R. Wilson, Treasurer of Philco Corporation, Treasurer. The Board of Directors will include the above officers of the company, Howard W. McAteer, President of American Steel Export Company, Inc., and Russell L. Heberling, a Director and Vice President of Philco Corporation.

Ownership of McAlear Manufacturing Co., Chicago, Ill., producers of valves, regulating and control equipment, was acquired by the interests controlling Climax Engineering Co., manufacturers of internal combustion engines, power units and generating sets, it was disclosed recently at the Climax home office in Clinton, Iowa. Edward F. Deacon, Climax president also will be president and general manager of the McAlear Co. it was stated in an announcement jointly issued by Mr. Deacon and Owen L. Coon, chairman of the board of General Finance Corp., of which both companies are now subsidiaries. Mrs. P. G. McAlear, formerly president and now chairman of the board of the McAlear Company, will continue to be actively identified with the management.

Experience of Westinghouse Air Brake Co. in the development and manufacture of pneumatic controls for railroads now is to be made available to the general industrial field, it is announced by George A. Blackmore, president. The



THE 'AIR ARM' OF INDUSTRY

Applying Compressed Air for countless jobs is one of Ingersoll-Rand's major contributions for the industries of war and peace.

Armies of drill runners mining the vital metals, building the strategic roads and air fields, driving the tunnels for highways, railroads and water—all with rock drills powered by Compressed Air.

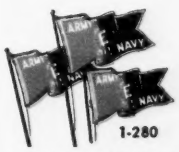
Thousands of men, women too, building planes, ships, tanks, autos, trucks, locomotives, bridges, machines, and process plants—with drills, grinders, riveting hammers, chippers, hoists—powered by Compressed Air.

Today's war production also emphasizes the use of Compressed Air for propelling torpedoes, scavenging guns, starting Diesels, for painting, for ship salvage, for blasting sirens, for inflation of tires, for blowing blast furnaces and cupolas to increase steel production. . . .

Ingersoll-Rand has pioneered Compressed Air Systems since 1871, ever developing new and time-saving applications.

Ingersoll-Rand

11 Broadway, New York, N. Y.



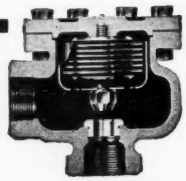
COMPRESSORS • TURBO BLOWERS • ROCK DRILLS • AIR TOOLS • OIL AND GAS ENGINES • CONDENSERS • CENTRIFUGAL PUMPS

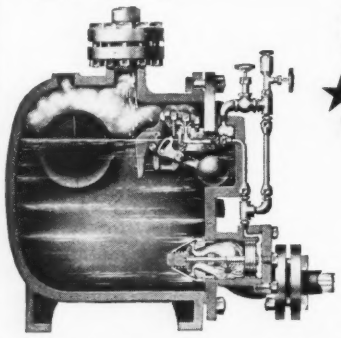
XUM

It Takes a Trap with Guts to Stand the Gaff of America's Round-the-Clock War Production

Nicholson Thermostatic Type Industrial Traps Provide Large Capacity . . . Long Life . . . 100% Efficiency.

Sizes ¼" to 2" . . . Pressures from vacuum to 300 lbs. . . . types for all applications.





★ **SPECIALLY DESIGNED TRAPS FOR SUPERHEATED STEAM SERVICE**

For dependable efficiency and economical durability, Nicholson makes a complete line of high pressure traps. Weight Operated for pressures to 1500 lbs.—Piston Operated for pressures to 650 lbs. Several models, various constructions, numerous sizes—for all purposes.

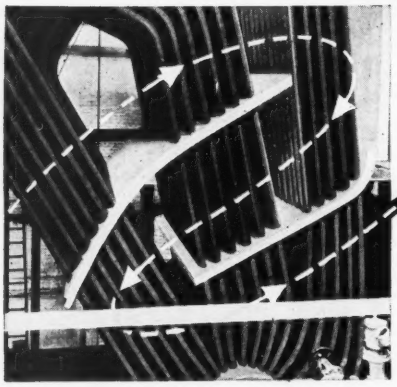
CATALOG No. 941—W. H. NICHOLSON & CO., 160 OREGON ST., WILKES-BARRE, PA.

NICHOLSON *Traps*

THERMOSTATIC ▼ PISTON AND WEIGHT-OPERATED STEAM GASOLINE AND COMPRESSED AIR TRAPS

CONTROL VALVES ▼ FLOATS ▼ MANDRELS ▼ STEAM AND AIR SEPARATORS

ENCO BAFFLES



Satisfy Hungry Heating Surfaces

. . . and many boiler heating-surfaces are literally and unnecessarily starved. They need Enco Baffles to increase heat absorption, to boost efficiency and to increase steam output. Enco Baffles revitalize boilers by providing streamlined cross-flow of gases over the tubes, and by eliminating eddy currents, bottlenecks and dead gas pockets. Bulletin BW40 gives further details. It is yours on request.

THE ENGINEER COMPANY

75 WEST STREET (Enco) NEW YORK, N.Y.

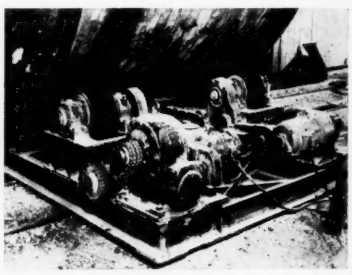
company's remote control systems already have been installed for the control of ships, on power shovels, and in the mining, petroleum and machine tool industries.

Among other industries being studied are automotive, aviation, building constructon, ceramic, lumbering, metal working, paper manufacturing and plastic. Development work on the new remote pneumatic control systems, supplemented when necessary by the adaptation of pneumatic-hydraulic and pneumatic-electric controls, is being done by the engineering staff of the company at Wilmerding.

NEWS FROM THE FIELD

Welding Shasta Dam Penstocks

WELDING of steel plates varying from ¾ to 2½ in. in thickness, to form penstocks 15 ft in diameter and 800 to 935 ft long for the Shasta Dam now under construction by the U. S. Bureau of Reclamation in the Central Valley (Calif.) project, is being done by the Western Pipe & Steel Co. which did the same work on the Grand Cou'ee Dam penstock.



Circumferential welds form curved steel plate into Shasta Dam penstocks. Steel plate is supported on rubber rollers with variable speed drive to turn penstocks at correct welding speed

Steel plate curved to the correct radius is received near the Shasta Dam and is welded by automatic equipment. To handle these large curved plates they are mounted on rubber rollers, as shown in the photograph. These rollers are revolved at the correct speed under the automatic welding machine. They are driven by a motor through a Link-Belt P.I.V. Gear variable speed transmission to permit infinite speed variations. The drive also includes a worm-gear speed reducer, Friction-Fighter roller bearing pillow blocks and Silverlink roller chain drives. After the circumferential welds have been made they are X-rayed by a portable X-ray machine traveling on rails parallel to the penstock production line.

After a section of the penstock is completed, it is given a hydrostatic test by bolting heavy heads onto each end. A compressed air impact wrench tightens the nuts on the head for this test. Working pressure to which the penstocks will be subjected varies from 240 to 475 ft head of water.

TROY-ENGBERG STEAM ENGINE

1... the drive that quickly returns its cost often within a year or two
2... the drive that offers several excellent drive characteristics
3... the drive that is noted for its dependability

OUTSTANDING economy . . . flexibility, wide speed range, high-starting torque, heavy overload capacity . . . year in, year out operation without need for major repairs! That's the record of thousands of Troy-Engberg Steam Engines operating today in power and process plants throughout the country.

If your plant conditions are right, the Troy-Engberg Steam Engine is the most modern and economical drive for your stoker, pump, compressor, generator, blower or fan. Don't fail to investigate it when you need such a drive . . . and can get the proper priority.

TROY ENGINE & MACHINE CO.

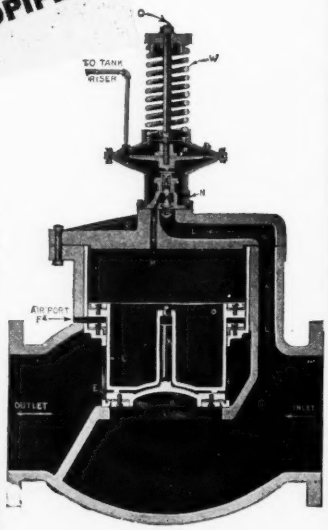
Established 1870

853 Railroad Avenue **Troy, Pennsylvania**

6—TEM—4

Is Your Water System protected against OVERFLOWING TANKS AND STANDPIPES?

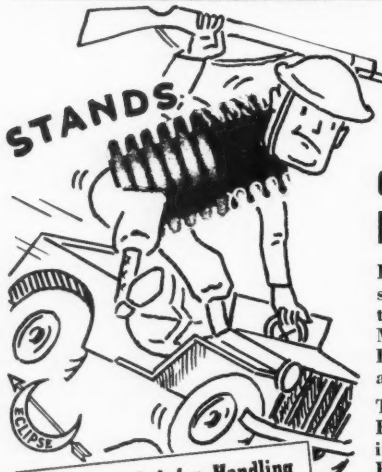
The Golden-Anderson Standard Altitude Valve, shown at right, is standing guard day and night on tanks and standpipes in every type of industrial plant and central station. This valve is positive in action, with no water hammer or shock, maintains a uniform water level at any set point. Comes in sizes 2 in. to 36 in., globe or angle pattern. Write for your free copy of the G-A catalog. It describes the entire line.



GOLDEN ANDERSON
VALVE SPECIALTY CO.
Fulton Building, Pittsburgh, Pa.

Also Triple Acting and Non-Return . . Pressure Reducing . . Check . . and other types of valves

ECLIPSE *SEAMLESS* METAL HOSE



of wartime work in lines handling liquids and gases

Don't take chances on costly production shutdowns due to tubing failures. Specify tougher, longer lasting Eclipse *Seamless* Metal Hose for Boiler Tube Cleaners, Diesel Engine Outlets, Steam, Lubricating Oil and other hard-used gas and liquid lines.

The extra flexibility and durability of Eclipse *Seamless* Metal Hose comes from its deep parallel sidewall corrugations. Eclipse *Seamless* Monel hose is stocked in sizes from ⅛ in. to 2 in. I.D.; steel hose up to 40 in. Easily attached fittings for any requirement.

Recommended for Handling
AIR • STEAM • CHEMICALS
GASES • OILS
HYDRAULIC • VACUUM, Etc.

Our engineers will be glad to work with you in licking your fluid conveying problems where flexing and expansion are encountered. Ask for more specific data and descriptive catalog.

Manufactured And Sold by

THE INVISIBLE CREW
Precision Equipment by Bendix
AVIATION CORPORATION

Dept. 19—Phila. Div.
Philadelphia, Pa.

National Oil and Gas Power Conference

ATTENTION of the ASME National Conference of the Oil and Gas Power Division will be focused on the use of Diesel engines in naval service, in a program featured by an address by Rear Admiral Earl Mills, Asst. Chief, Bureau of Ships, an inspection trip to the world-famous U. S. Naval Experiment Station, and a technical session devoted to maintenance of naval Diesel engines. The meeting will be held June 14-16, with headquarters at the Lord Baltimore Hotel, Baltimore, Md.

At the Exhibit held in connection with the Conference, more than 20 leading manufacturers of engines and accessories will display the latest in equipment and research developments.

On the program as tentatively arranged are the following papers, discussions and inspection trips:

Maintenance of Diesel Engines in Naval Service, by Engine Division, Bureau of Ships, Navy Dept. To be followed by prepared discussions from representatives of engine builders.

Informal Banquet at which Rear Admiral Earl Mills, Asst. Chief, Bureau of Ships, Navy Dept., will be principal speaker.

Investigation of Large Diesel-Engine Wristpins, by Frank E. Faast, Navy Department.

A New Approach to Stress-Strain Calculations for Connecting Rods, by Otto R. Spies, Baldwin Locomotive Works.

Inspection trip to U. S. Naval Experiment Station at Annapolis.

Present Position and Future Prospects of Diesel Fuels, by A. L. Foster, Oil and Gas Journal.

The Supersonic Reflectoscope for Inspecting Materials, by Professor F. A. Firestone, University of Michigan.

Recent Developments in Chrome-Plating of Engine Cylinders, by Russell Pyles, Van der Horst Corp. of America.

Experience with Chrome-Plated Rings, by Dr. Tracy Jarrett, American Hammered Piston Ring Division, Koppers Co.

Inspection trip through largest piston-ring plant, including new metallurgical laboratory and chrome-plating shop—American Hammered Piston Ring Div.

Pipe Line Project to Cost $75,000,000

WAR EMERGENCY PIPE LINES, INC., Rector Building, Little Rock, Ark., has awarded contracts for construction of a new welded steel pipe line for gasoline transmission from oil refineries in Southeast Texas to Seymour, Ind., by way of Little Rock. The awards have been made to a number of contractors covering different sections of the line. The first section, 16-in. pipe, will extend from Baytown and Port Arthur to Beaumont, Texas; from this point, two 20-in. pipe lines will be built to Little Rock, and a single 24-in. line from that city to Seymour, with extension to Norris City, Ill. A series of pumping stations for booster service will be built at points along route, developing a rated capacity of 225,000 to 235,000 bbl per day. The new line will cost about $44,000,000 and is expected to be ready for service in October. Primary contracts for the construction have been let to Williams Brothers, National Bank of Tulsa Building, Tulsa, Okla.; B. & M. Construction Co., Petroleum Building, Oklahoma City,

AN ELEVATOR, A CONVEYOR AND FEEDER IN A SINGLE UNIT

Bulk-Flo CONSERVES IN MANY WAYS

Bulk-Flo is outstanding in its ability to cut handling costs and to conserve critical materials and save space. It minimizes breakage and degradation, prevents leakage and reduces explosion and fire hazards. The necessity for multiple elevating and conveying units is eliminated, because the same unit conveys horizontally, vertically or on an incline.

Bulk-Flo is self-feeding, self-discharging and to a high degree self-cleaning. It handles coal and other flowable materials under all conditions of loading. It loads automatically —at one or at several points—without feeders. It automatically discharges at the head end of vertical runs or at one or more points on horizontal runs, or both as desired.

LINK-BELT COMPANY

Chicago Philadelphia Indianapolis Atlanta Dallas San Francisco Toronto

Offices, warehouses and distributors in principal cities.

Saves Space

Bulk-Flo is unusually compact, effecting a considerable saving in space requirements and supporting structure.

More Flexible

Bulk-Flo can be laid out to carry vertically, horizontally, around corners, along curves and on slants of any degree. Loading and discharge points can be located to suit. Tandem units can also be used.

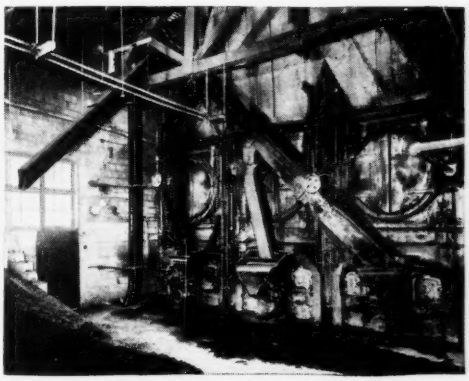
Self-Feeding, Enclosed

Bulk-Flo is self-feeding to capacity from bins, hoppers and chutes. It cannot flood. Material is moved in a dust-tight casing. It operates under partial loading with as high efficiency as when fully loaded.

Slow Speed; Large Capacity

Because the material in a Bulk-Flo moves en masse, the speed is slow; usually 30 to 60 ft. per minute. Large capacities are obtainable by large duct cross section, rather than by speed.

An interesting application of Bulk-Flo conveyor-elevator-feeder to the handling of coal in a plant power house. The Bulk-Flo transfers coal from bins near floor level to a screw conveyor which distributes it to stoker hopper.

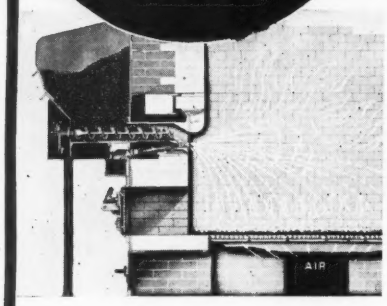


Vertical run of Link-Belt Bulk-Flo unit (left) in boiler room. 3-way chute system to three boilers and chute to reserve storage pile on floor. Bulk-Flo receives coal from hopper under railroad cars.

9105-A

Beat

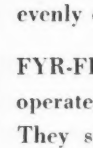
THE OIL SHORTAGE WITH FYR-FEEDER MULTIPLE SPREADER STOKERS!



FYR-FEEDERS burn coal like oil. Any coal — even screenings and sweepings. Fires burn in suspension while larger pieces are spread evenly over the grate.

FYR-FEEDERS are easy to operate, efficient, economical. They save fuel and money, produce steam quickly and increase boiler capacity.

You don't have to worry about the oil shortage. It's easy to change over to a FYR-FEEDER and burn any available coal efficiently. Plan now to do it.



WRITE FOR CATALOG

Describes unique FYR-FEEDER operating principle — shows you how to beat the oil shortage.

AMERICAN
COAL BURNER CO.
ENGINEERS, Est. 1918
22-18 E. Erie St. • Chicago

Okla.; and Oil States Construction Co., Tulsa Loan Building, Tulsa. From the terminus noted, surveys are in progress for a further development of this project, providing for an extension to harbor district at New York, N. Y. As now planned, this will be a 20-in. welded steel pipe line, similarly provided with a number of booster pumping stations at different points. It is proposed to have this section of the line ready for service by the close of 1943. It is estimated to cost close to $31,000,000. The cost of entire development will be financed by the Government through Defense Plant Corp., Washington, D. C., Federal agency.

Another Generator in Service at Grand Coulee

EARLY IN MAY, another 70,000-kw hydraulic turbine was placed in service at the Grand Coulee hydroelectric power development of Government, Grand Coulee, Wash., under direction of Department of Interior. This is the second such machine to be placed in operation during the past three months, the first being added to the station capacity in February. The two 70,000-kw units were originally constructed for use at the Shasta Dam development in California, and later transferred to Grand Coulee. The change was made to provide power supply for the rapidly expanding war industries in the Pacific Northwest.

Chemical Exposition Dates Announced

DATES FOR THE 19th Exposition of Chemical Industries have been definitely set for the week of December 6 to 11, 1943. Announcement was made by Charles F. Roth, Manager of the Exposition. This year Madison Square Garden will be the scene of the event instead of Grand Central Palace. The change results from the fact that the U. S. Army has commandeered the exposition floors of the Palace as an induction center.

Army Hospital to Cost $7,500,000

THE WAR DEPARTMENT, Washington, D. C., has approved plans for a new army general hospital on York Road, near Pleasant Valley Road, Parma, near Cleveland, Ohio. As now arranged, it will consist of a group of 107 buildings and will provide a total of about 1550 beds. In addition to main multi-story hospital structures, project will include a steam-electric generating station, ice and refrigerating plant, warehouses, shops, clinical and storage buildings, mess halls, barracks, guardhouse, postoffice, visitors' lounge, administration building, fire station and miscellaneous buildings. It is estimated to cost from $7,500,000 to $9,000,000 complete. Contracts for certain parts of work have been awarded and bids are being called at different intervals for certain groups of buildings. It is proposed to have entire project under way in course of a few months. Wilbur Watson & Associates, 4614 Prospect Ave., Cleveland, are architects; Major A. H. McCarnes is area engineer in charge. Program will be carried out under direction of U. S. District Engineer, Lt.-Col. Herbert D. Vogel, New Federal Building, Pittsburgh, Pa.

The Problem of the 225 p. p. m.

From ILLCO's Case Book of Boiler Feed-Water Treatment . . .

A LARGE PUBLIC UTILITY needed more equipment. Expansion prompted it to find out if there was a better method of water treatment for its boilers (both low and high pressure type). Previously, it had operated with two older and accepted types of treatment. Various concerns were called in, including the Illinois Water Treatment Company.

THE UTILITY'S RAW WATER SUPPLY contained 225 parts per million of dissolved solids, of which 161 p.p.m. were scale-forming. The amount of make-up water required was 32,000 gallons per hour, 24 hours a day.

COMBINATION-REGENERATION equipment was recommended by ILLCO. This consisted of three reactor tanks (9 ft. diameter, 7 ft. high), containing ion-exchange material to be *regenerated simultaneously with salt and acid*—a process pioneered by ILLCO and which has demonstrated its excellence for over five years in leading industrial plants.

PRODUCING THE REQUIRED MAKE-UP of 32,000 gallons per hour of water free from scale-forming solids and having a total dissolved solid content of less than 40 p.p.m., this unit and this method provided the ideal solution.

NOTEWORTHY ADVANTAGES: Lower dissolved solid concentration in the boiler water, therefore fewer blow-downs and a saving of fuel. Less supervision: only attention required is periodic regeneration. Even when raw water supply varies, quality of treated water is maintained. On comparative cost of chemicals alone, equipment will pay for itself in less than four years. Other operating expenses also greatly reduced—less fuel consumption, lowered maintenance, etc.

WITHOUT OBLIGATION we'll gladly make a similar survey of *your* boiler feed-water problem, suggest recommendations, describe our equipment in detail.

Also engineered and manufactured by ILLCO are De-ionizing Units, Softeners, Filters, Aerators, Chemical Processing Equipment, etc. Write for literature.

TESTED IN THE LABORATORY ILLCO-WAY PROVED IN THE FIELD

ILLINOIS WATER TREATMENT CO.
850 Cedar Street, Rockford, Illinois

TO HIT 'EM H-A-R-D-E-R

THE year 1943 promises to be the grimmest, hardest year this country has ever faced. Every effort, and every dollar of national income not absolutely needed for existence, should go into war work and War Bonds.

In the Pay Roll Savings Plan, America finds a potent weapon for the winning of the war—and one of the soundest guarantees of the preservation of the American way of life!

Today about 30,000,000 wage earners, in 175,000 plants, are buying War Bonds at the rate of nearly half a billion dollars a month. *Great as this sum is, it is not enough!* For the more dollars made available now, the fewer the lives laid down on the bloody roads to Berlin and Tokio!

You've undoubtedly got a Pay Roll Savings Plan in your own plant. But how long is it since you last checked up on its progress? *If it now shows only about 10% of the gross payroll going into War Bonds, it needs jacking up!*

This is a *continuing* effort—and it needs *continual* attention and *continual* stimulation to get fullest results.

You can well afford to give this matter your close personal attention! The actual case histories of thousands of plants prove that the successful working out of a Pay Roll Savings Plan gives labor and management a common interest that almost inevitably results in better mutual understanding and better labor relations.

Minor misunderstandings and wage disputes become fewer. Production usually increases, and company spirit soars. And it goes without saying that workers with substantial savings are usually far more satisfied and more dependable.

And one thing more, these War Bonds are not only going to help win the war, they are also going to do much to close the dangerous inflationary gap, and help prevent post-war depression. The time and effort *you* now put in in selling War Bonds and teaching your workers to save, rather than to spend, will be richly repaid many times over—now and when the war is won.

★ ★ ★

You've done your bit Now do your best!

This space is a contribution to victory today and sound business tomorrow by POWER PLANT ENGINEERING

XZIT

FIRE SCALE and SOOT ERADICATOR

offers a simple way to step up **BOILER EFFICIENCY** *without a shut-down!*

XZIT, a scientific compound, increases operating efficiency by eliminating soot and fire scale from boiler heating surfaces, uptakes, breechings and stacks. In addition, it discourages further formation of these undesirable carbon deposits and saves steam by reducing soot-blowing.

INVESTIGATE XZIT TODAY

Write for complete information concerning the advantages of using XZIT.

XZIT SALES CO.
1031 CLINTON STREET
HOBOKEN, NEW JERSEY

Lincoln Foundation Awards

HERMAN J. BRENNEKE of New York University won the first award of $1000 and four scholarships of $250 each in the recent James F. Lincoln Arc Welding Foundation contest for engineering undergraduates for his paper entitled, Arc Welding versus Casting in the Design of Jigs and Fixtures. Robert Edson Lee of Iowa State College, Ames, Iowa, won the second award of $500 and two scholarships of $250 for his paper entitled, An Arc Welded Chair. Charles L. Sammons and John H. Stewart of Ohio State University, Columbus, Ohio, jointly received the Foundation's third award of $250 and a $250 scholarship for their paper describing the application of arc welding to the design and construction of a radio tower. In all, 77 awards totaling $5000 and 7 scholarships totaling $1750 were awarded in the contest.

American Automatic Heating Corp. Organized

AMERICAN AUTOMATIC HEATING CORP., newly organized, with executive offices in the Newsweek Building, 152 West 42nd Street, New York, N. Y., will specialize in oil to coal conversion problems in cooperating with local WPB and OPA policies, throughout the Metropolitan, New York area, including Staten Island, Westchester and Rockland Counties, Southern Connecticut and adjoining New Jersey areas.

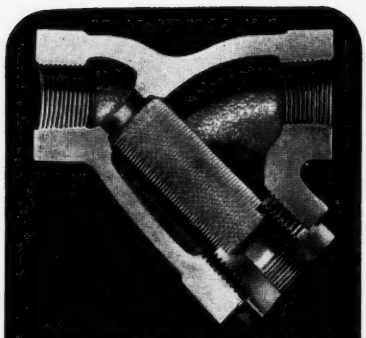
Branch offices and trained heating engineers are available to consult with war plant executives, realty and building managements, municipal authorities, etc., on converting heating plants now using oil to equipment burning coal.

Officers of the Corporation include H. W. Clarke, President; L. J. Kennedy, vice-president of McGraw-Hill Publishretary-Treasurer; and Otto Kuhler, Consulting Engineer. Mr. Clarke, former vice-president of McGraw-Hill Publishing Co. and publisher of Coal Age, has been associated with the coal industry for the past 20 years.

Mr. Kennedy is a heating engineer who has been actively engaged in engineered automatic heating in all its branches, with special knowledge of Metropolitan heating and fuel conditions for the past 10 years. He was formerly manager of heating equipment and service departments for a prominent Metropolitan heating equipment company, and for the past four years has specialized as a consultant on oil, coal and gas heating plans for industrial, commercial and residential conditions, with offices on Staten Island, at 130 Bay Street, which now becomes a branch of the new firm.

Mr. Stohldrier is president of the Westchester Chapter of the American Institute of Architects, a member of the Town Board of the Town of Eastchester, Past President of the Board of Education, Eastchester, New York, and a partner in the firm of Stohldrier & Zetsche, with offices in the Peoples Bank Building, White Plains, New York, where a branch of the American Automatic Heating Corp. will likewise be opened shortly.

Mr. Kuhler, who will act as consulting engineer, is a designer and engineer who has specialized in streamlining railroad trains.



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Why don't you look into this better Strainer for your money? Buy one from your supply house (over 100 Mill Supply Houses now have them).

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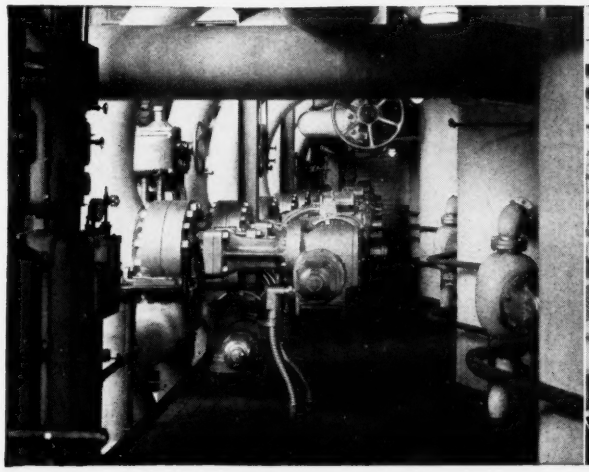

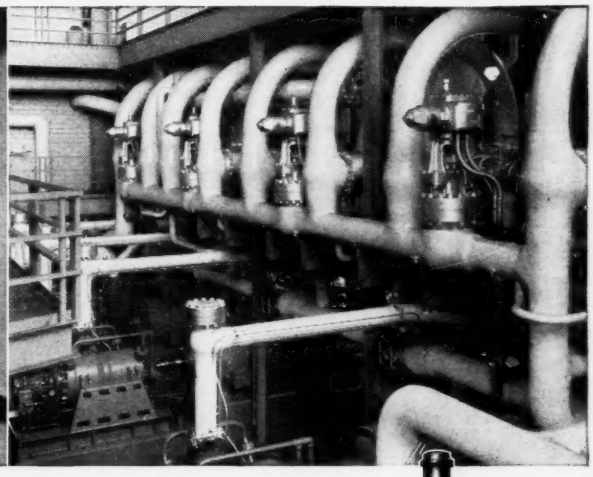

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Limitorque Controls at Burlington provide centralized push button control of valves *ranging from those on 12"—1250 pound steam lines to those on 3"—300 pound oil lines, and on water from 48" gate valves to 9' wide x 10' high sluice gates* . . . in normal, every day operation of the station as well as for emergency and safety purposes. This keeps the operation of important valves under the watchful control of responsible, key men.

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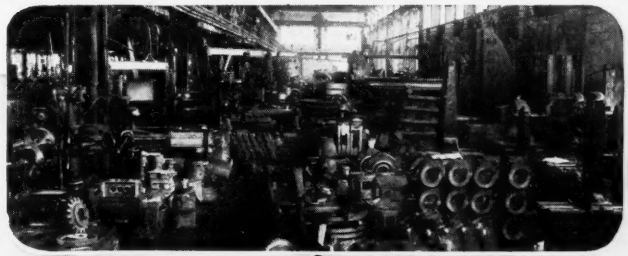

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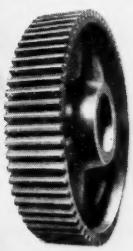

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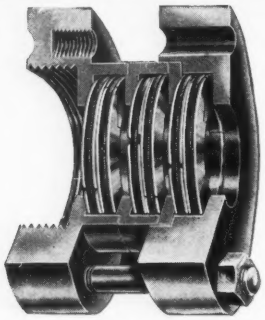

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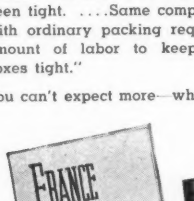

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A.S.H.V.E. Meeting at Pittsburgh

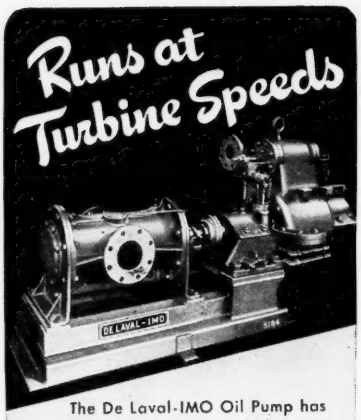
THE 1943 SEMI-ANNUAL MEETING of the American Society of Heating and Ventilating Engineers will be held at the William Penn Hotel, Pittsburgh, Pa., June 7 and 8.

The Council and Committee on Research plan to meet in advance of the general sessions and during the two-day conference four technical sessions will be held. The meeting will be called to order by M. F. Blankin, President of the Society, on Monday, June 7, and the subjects selected by the Meetings Committee will bring out a number of discussions on topics of immediate current interest, as well as research results that have been developed under the cooperative program sponsored by the Society in various colleges and universities. The only entertainment feature of the meeting will be the Semi-Annual Dinner on June 8 at which the principal speaker will be Dr. Allen A. Stockdale whose subject will be Democracy Can Do It. At the dinner the Past President's emblem and the Past President's Memory Book will be presented to Prof. E. O. Eastwood of Seattle, Wash.

The papers to be presented at the four technical sessions are as follows: Performance of a Residential Panel Heating System, by H. F. Randolph and J. B. Wallace; Operation of a Heating Plant Using Sun Energy and Radiant Heating, by W. C. Knopf, Jr.; Final Values of the Interaction Constant for Moist Air, by John A. Goff, J. R. Andersen and S. Gratch; Study of Actual vs. Predicted Cooling Load on an Air Conditioning System, by J. N. Livermore; Spray Nozzle Performance in a Cooling Tower, by L. M. K. Boelter and S. Hori; Use of the Down Draft Coking Principles for Smokeless Combustion, by J. R. Fellows and J. C. Miles; Field Study of Comfort Reactions of Apartment Dwellers Under Fuel Oil Rationing, by Sallye Hamilton; Heat Transmission Through Insulation as Affected by Orientation of Wall, by F. B. Rowley; Graphical Method of Calculating Heat Losses, by P. D. Close; The Economic Factors in Converting Recirculated Air for Ventilation, by H. E. Ziel and Henry Sleik; Panel Discussion on Will Current Ventilating System Operation Undermine Public Health and Efficiency?

New Welding Library at Ohio State

A NEW LIBRARY on welding, believed to be the most extensive in existence and one which will be of inestimable value in welding development, has been established at the Ohio State University, Columbus, Ohio. A gift of A. F. Davis, vice president and secretary of The Lincoln Electric Company, the library is known as the A. F. Davis Welding Library, and makes available for the first time in one place all important literature on welding. The library will be of special value to industrial designers, engineers, technicians and others interested in research or general information on the various forms of welding and their application to design, construction, manufacture or maintenance of metal products and structures. Welding students will also find the library of great benefit.



The De Laval-IMO Oil Pump has only 3 moving parts, which are in perfect rotational balance, and no gears, valves or separate bearings. It can be coupled directly to standard speed motors and turbines to deliver any grade of oil in any volume against any pressure. The turbine-driven lube oil pump here shown is one of five in service on the World's largest ore carriers.

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HELPFUL BULLETINS

Practical answers to many wartime problems of plant operation and maintenance are found in the engineering bulletins offered by manufacturers. For your convenience we publish the following summary of helpful literature available. To obtain copies of the bulletins and catalogs described, simply indicate the paragraph numbers on coupon on next page, detach and mail.

BOILER PLANT EQUIPMENT

1 Refractory Concrete — 24-page book features characteristics of Lumnite, methods of making refractory concrete, heat-resistant concrete and refractory-insulating concrete. Book contains many photographs and tables. Atlas Lumnite Cement Co.

2 Steam Generators — Design features and specifications of Clayton Kerrick steam generators are presented in new bulletin. These units deliver 10 to 150 hp; 10 to 150 lb pressure; meet the needs of many heating plants, laundries, vulcanizing plants, decontamination stations, etc. Fully automatic, compact, easy to install. The Clayton Mfg. Co.

3 Integral Furnace Boiler — Illustrated bulletin G-34 gives complete data on integral furnace boiler, either stoker firing or oil burning. Can be quickly converted to burn whichever is the more economical fuel. Outstanding features of this unit are described in detail and cross sectional views show typical installations. The Babcock & Wilcox Co.

4 Faster Furnace Repairs — Illustrated folder on Clipper masonry saw tells how this unit cuts firebrick faster; eliminates whittling with hammer and chisel; saves both time and labor on furnace repairs. Cuts silica brick in 9 seconds. The Clipper Manufacturing Co.

5 All Purpose Stoker—Bulletin No. 500 describes advantages of the Canton De Luxe worm feed stoker for small and medium sized industrial and commercial applications. Features include side ash dumps, extra grate area, zoned air control, dur-alloy steel hopper. Canton Stoker Corp.

ELECTRICAL EQUIPMENT

6 Automatic Battery Charger—Automatic battery-charging equipment for motive-power batteries is the subject of a new, illustrated 8-pg. bulletin (GEA-3923). It covers in detail the single battery control, multiple circuit battery control, and the motor-generator sets. Also describes the G-E charge-control units for automatically discontinuing the charging of batteries when they have received the correct amount of charge. Gives a table for determining the approximate kw rating of a generator for charging any number of batteries of the same size by the modified constant-potential method. General Electric Co.

7 Electrical Contacts—New 36-pg. illustrated, two-color catalog describes the design and application of electrical contacts of silver, platinum, tungsten, molybdenum and a variety of other metals and alloys. Covering types of contacts, their physical size and shape, and the particular applications to which each metal and alloy is best suited, this new catalog offers the design and production engineer a complete story on electrical contacts. Callite Tungsten Corp.

8 Voltage Regulator—A new 24-pg. booklet, B-6056, is devoted to the subject of voltage regulators of the "unit construction type." The book is amply illustrated with installation photographs, operational drawings and standard rating charts. It also contains a section describing the theory of the step type regulator operation. Allis-Chalmers Mfg. Co.

9 Communication Equipment — A new buyers' guide for 1943 covering everything in radio and electronics has been issued. Included are complete listings of transformers, resistors, condensers, rheostats, relays, switches, rectifiers, electronic tubes, tools, wire and cable, batteries, sockets, generators, power supplies, converters and all other types of equipment in this field. Public address and intercommunication units are listed for every outdoor and indoor requirement. The guide contains a technical book section on radio, electronics and electricity. Allied Radio Corp.

10 Lighting Guide—Up-to-the-minute information on the use of fluorescent luminaires for factories and offices is given in new lighting catalog. Includes diagrams, specifications, price lists. Martin-Gibson Light & Tile Corp.

11 Rheostats—Bulletin No. 550 describing a new line of slide contact rheostats and fixed tubular resistors with adjustable band has just been issued. Well illustrated with photographs and drawings and contains tables of sizes, capacities and list prices. Herman H. Sticht Co., Inc.

12 Gearmotors—Booklet B-3218 describes in detail the new Westinghouse gearmotor and illustrates practical applications for this equipment. For war production, these gearmotors are standardized for easy application, and in postwar conversion these units can be moved easily to new locations. Westinghouse Electric & Mfg. Co.

13 Motor Control—How to select and apply motor control is explained in a new, easy-to-read, 16-pg. manual (GEA-4015), "Simplified Guide to the Selection and Application of Commonly Used Motor Controls." Starting with a simple analysis of the functions of control, the booklet next describes the basic control parts of industrial devices. Following this is a discussion of the selection of correct control, explaining how to choose between manual or magnetic, and when reduced-voltage starting is necessary. Many illustrations and explanatory diagrams for visual aids. General Electric Co.

14 Panelboards—Bulletin No. 69 recently issued contains information on panelboards and cabinets that should be of interest to contractors and engineers concerned with electrical wiring. Frank Adam Electric Co.

FANS, PUMPS AND COMPRESSORS

15 Centrifugal Pumps—Interestingly described in Bulletin No. 4200 is the Deming-Mueller single stage side suction centrifugal pump. This unit is widely used in chemical, paper, dairy, sugar refinery, laundry, oil and steel plants. Bulletin contains tables on friction of water in pipes and other pump engineering data. The Deming Co.

16 Power Driven Air Compressors—Features of design and operation of Bury horizontal power driven air compressor are presented in illustrated Bulletin 423. These machines are built for pressures 5 to 125 lb, capacities up to 2000 cu ft per min. Bury Compressor Co.

17 Pumps and Hydraulic Equipment—New 16-pg. illustrated catalog shows representative pumps and hydraulic equipment for power plants, oil fields, process industries and marine use. Text is descriptive of the many types of pumps shown and lists their applications. Issued by The Aldrich Pump Co.

18 Compressed Air Conservation — New series of wall posters entitled "Use the air you need but don't waste it" helps wage war on leaky hose couplings, valves and pipe fit-

List Items You Want On Handy Coupon On Following Page

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tings. Printed in two colors; shows right and wrong methods of using compressed air. Ingersoll-Rand Co.

19 Fixing Worn Pump Rods—Four different methods for renewing worn metal parts such as pump rods and shafts are described in a new booklet entitled "How to Recondition Worn Pump Shafts and Rods." Using a worn pump shaft as practical example, the booklet explains and illustrates the step-by-step procedures for reconditioning the shaft: by machining and refinishing the worn section, by building up and refinishing the section by welding, by metal spraying, and by heavy and hard electrodeposition. The International Nickel Co., Inc.

20 Positive Displacement Gas Pumps—Bulletin 31-B-15, covering Victor-Acme positive displacement gas pumps, shows various types of driving arrangements which make these gas pumps readily adaptable to a wide range of industrial applications. Advantages in construction are discussed, together with sectional views emphasizing the various features. A diagram shows volume and power characteristics at constant and variable speeds. Capacity covers a range from 5 to 700 CFM. Roots-Connersville Blower Corp.

INSTRUMENTS AND CONTROLS

21 Indicating and Recording Controllers—Catalog 1200, entitled Tag Indicating and Recording Controllers for Temperature and Pressure, is a comprehensive presentation of three types of controllers—On-Off, Throttling and Automatic Reset—which are of such vital importance in the war effort. Many illustrations show how these pressure-spring controllers operate. Actual installation photographs also tell an interesting story of what Tag indicating and recording controllers are doing. C. J. Tagliabue Mfg. Co.

22 Air Operated Controllers—An 8-pg. Bulletin No. A112 has just been published describing a line of new Bristol convertible free-vane air-operated controllers recently developed. Data is given in the bulletin on the five types of controllers offered along with information on converting from one type to another. The Bristol Co.

23 Gages for Measuring Liquids—Bulletin 1037 describes a complete line of liquid level gages for measuring liquids of all kinds whether light or heavy. Dial readings can be provided in feet, inches, gallons, pounds, liters or by any other desired increment. The Liquidometer Corp.

24 Jet Pipe Principle of Control—Bulletin 118 illustrates and describes fully the hydraulic jet pipe principle of automatic control. The folder clarifies the principle, advantages and the functions of the jet pipe and is of interest to engineers coping with difficult and critical control problems. Uses are detailed and sectional drawings are reproduced. Askania Regulator Co.

25 Combustion Meters—Bulletin No. 39-297—16-pg. treatise "Measuring Combustion"—gives the principles of combustion and its measurement in terms of CO_2. Illustrates several types of combustion meters, giving principle of operation. The Hays Corp.

MECHANICAL TRANSMISSION

26 Gear Data Book—Combination catalog and gear data book, 72 pg., includes dimension tables for various gear types, as well as data on speed reducing units, motoreducers, and electric hoists. Also contains engineering data section. Philadelphia Gear Works.

27 Variable Speed Drive—Bulletin No. 501, "When To Use The Graham Variable Speed Drive," is based on an analysis of successful applications of the Graham unit in many different industries. A helpful technical guide for engineers who design or operate power machinery. Graham Transmissions, Inc.

28 Reducer Type Transmission—New Catalog TR-432, 16 pg., tells all about the design and application of the Reeves variable speed transmission with built-in reducer. Also contains useful engineering data and rating tables for the selection of proper transmission units. Reeves Pulley Co.

PIPING, VALVES AND FITTINGS

29 Pipe Welding—Useful 16-pg. booklet entitled "The Welding of Piping" consists of a series of articles prepared by company's applied engineering department. Covers various type of ferrous and non-ferrous piping, dimensions, fabrication and estimates of labor and welding costs. Air Reduction Sales Co.

30 Limitation Order On Valves—New bulletin sets forth the changes which WPB Limitation Order No. L-252 (effective May 1) makes necessary in Fairbanks iron and bronze valves as to types, sizes, pressures and construction. The Fairbanks Co.

31 Steam Traps—A 4-pg. folder on the Corliss Steam Trap stresses the simplicity and efficiency of the valve mechanism and outlines its working principles. Dimension tables as well as sizes and capacities are shown. W. B. Connor Engineering Corp.

32 Quick Action Valves—The full line of Okadee lever operated quick action valves is pictured and described in Catalog No. 40. These valves are widely used for boiler blow off, storage tanks, water columns, laundries, gasoline loading racks, etc. The Okadee Co.

33 Fully Automatic Packing—New bulletin covers characteristics and application of Chesterton Parachute packings for steam, water, air, gas, hot and cold oils, solvents. This moulded packing is said to require no gland pressure and to be fully automatic. A. W. Chesterton Co.

34 Valve Reseating Machines—New Catalog 40—32 pg.—offers complete explanation of construction and operation of valve reseating machines for either gate, globe or pump valves. Easily operated, reliable, efficient and durable, these machines save many valves from discard. The Leavitt Machine Co.

35 Heat Exchangers—A 4-pg. bulletin describes a new line of heat exchangers for use as lubricating oil coolers, jacket water coolers, vapor condensers, condensate coolers, compressed air after-coolers, gas coolers, and other miscellaneous cooling duty. These are high efficiency units, very compact in construction and easily installed. Downingtown Iron Works.

36 Pressure Piping Data—New Bulletin 42-C will be found helpful by engineers concerned with the design, specification and installation of pressure piping. Emphasizes the differences in piping requirement of ASME Boiler Code and recently revised ASA Code for Pressure Piping. Midwest Piping & Supply Co.

PRIME MOVERS

37 Mechanical Drive Turbines—Mechanical drive turbines—designed to produce economical power as a by-product of process steam—are described in Bulletin GEA-1145-B. Contains specifications, installation diagrams and other helpful data. General Electric Co.

38 Gas Turbine Developments—Attractive 24-pg. Bulletin B-6078 outlines the history and current trends in the development of the gas turbine. Charts and data on thermal efficiency;

This coupon must be filled in completely in order to secure the literature you request. Please indicate only the bulletins you particularly desire. Pasting coupon on penny postcard saves you time and money.

JUNE, 1943

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also photos and details on application in oil refineries. Allis-Chalmers Mfg. Co.

39 Diesel Engines—12-pg. Bulletin No. S-500-B36B covers type CC Diesel engines with specifications, auxiliaries, application data, cooling equipment, principal dimensions, and ratings. Also includes photographs and cross-sectional diagrams. Worthington Pump and Machinery Corp.

40 Engine Valve Grinding Equipment—Equipment best suited for grinding valve seats and valve faces in the various types of Cooper-Bessemer engines is pictured and described in a new folder entitled "Recommended Valve Seat Grinding Equipment." Basic set of tools includes: (a) high speed driver; (b) valve grinder; (c) dressing tool and pilot; (d) valve seat indicator; (e) pin for removing tapered pilots; and (f) grinding wheel holders. The Cooper-Bessemer Corp.

41 Lubrication Handbook — "Diesel Engine Lubrication" is the title of a 16-pg. booklet telling about Cities Service oils for Diesel engine use. Stresses importance of correct lubrication from both a maintenance and operating standpoint. Recommendation chart shows proper grades of principal brands of this company's Diesel engine oils, listed in accordance with engine builder's specification. Cities Service Oil Co.

WATER TREATMENT

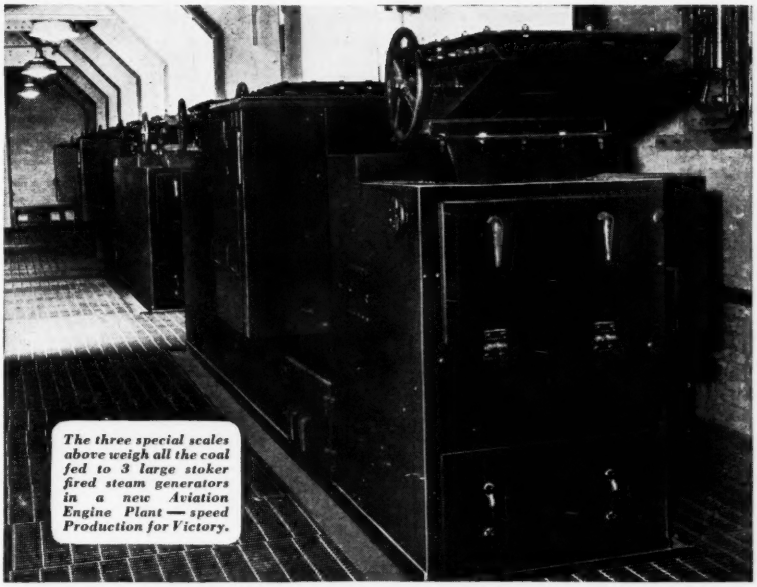
42 Wartime Water Treatment Methods—"New Water Developments and Wartime Economy" presents a discussion of the published specifications which deal with the quality of process water required for the manufacture of different grades of paper. Treatment methods to fit raw water for specific manufacturing uses are reviewed. Recent progress in analytical plant control for high pressure boilers is touched upon, and recent important articles on the preservation and maintenance of equipment under corrosive conditions are summarized. Designated as Betz Technical Paper No. 82, it will be furnished free on request to W. H. and L. D. Betz.

43 New Edition of "Organic Methods"—A new fifth edition of the booklet on "Organic Methods of Scale and Corrosion Control," a helpful text on the use of organic chemicals in water treating, is just off the press. Contains a number of charts, graphs, tables and halftones to illustrate the usefulness of organic chemicals in water conditioning and point the way to substituting these efficient and available chemicals for products which are now obtainable with difficulty, if at all. D. W. Haering & Co.

44 Scale and Slime Removal — New folder describes Sol-vet "08," a recently developed chemical compound for the effective removal of scale, rust, dirt and algae in water-cooled condensers, circulating lines, cooling towers, etc. Said to be harmless to pump, pipe, hose, valves and connections. Anderson-Stolz Corp.

45 Demineralizing Solutions — Process industries requiring water as pure as distilled water, will find useful a paper on "Demineralizing Solutions by a Two-Step Ion Exchange Process"

(*Continued on Page* 182)



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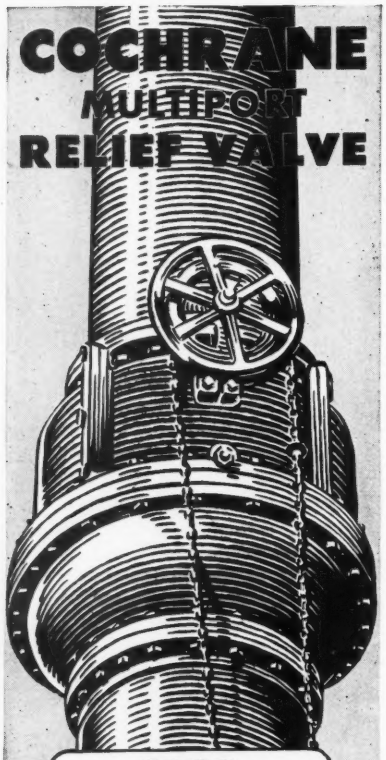

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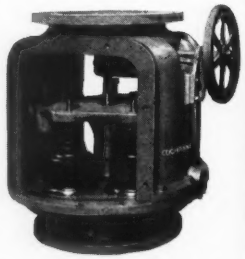
Danger from sticking, jamming or freezing is eliminated by the multiplicity of valve disks instead of one large disk.



Chattering and pounding are also absent because the valve disks are light in weight with short travel and are further steadied by individual cushion chambers. Pressure is easily adjusted by varying the compression of the valve springs, which is done by shifting the pressure plate by means of a hand wheel, chain or motor.

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by Howard L. Tiger and Sidney Sussman. The two-step ion exchange process—involving removal of cations by a sulfonated coal (Zeo-Karb) and adsorption of formed acids by a solid organic amine (De-Acidite)—has been successfully applied to producing ion-free water for use in such operations as the manufacturing of synthetic organic materials, mirrors, synthetic rubber, various chemicals, and in feeding boilers The Permutit Co.

46 **Boiler Water Conditioning**—Bulletin 504 covers the "inside story of boiler water conditioning" by explaining the types of impurities found in boiler feedwater, how these impurities accumulate, what happens when subjected to boiler temperatures, the common cause of boiler scale, sludge, corrosion and carryover and how to prevent these troubles. Also describes the Elgin Deconcentrator—a simple, ingenious boiler attachment for clarification of boiler water. Elgin Softener Corp.

MISCELLANEOUS

47 **Work-Lites**—Bulletin 102 in four pages with illustrations and sectional views describes the Swivelier Work-Lites which are adjustable and unaffected by machine vibration. Applications on machines and work benches are pictured, and specifications are detailed. Reliance Devices Co., Inc.

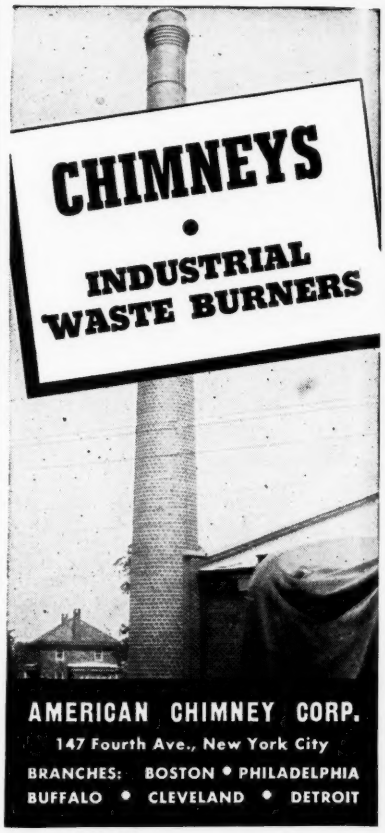
48 **List of Engineers' Handbooks**—New folder describes contents and prices of Audels guides for engineers and mechanics. These handbooks explain theory and operation of automobile engines, welders, Diesel engines, refrigeration, light and power wiring systems, etc., also aids to engineers' examinations, with q. and a. Theo. Audel & Co.

49 **Crane, Dragline, Shovel Catalog**—A new 24-pg. illustrated catalog No. 1960 has just been issued describing the 2 to 3 yard Speed-o-Matic series "500" cranes, draglines and shovels. Features include hydraulically-controlled steering and braking; self-aligning rotating rollers; perfect-guiding non-clogging crawler treads. Eight pages are devoted to dimensions, clearance diagrams, working ranges, lifting capacities and brief specifications. Link-Belt Speeder Corp.

50 **Keeping Fluids Clean**—Helpful filter installation booklet titled "Quick Facts on Keeping Fluids Clean" gives tips on maintenance of gas and Diesel engines, turbines, blowers, burners, combustion controls, lubricating and cooling systems. Includes actual case studies and engineering data. The Cuno Engineering Corp.

51 **Photo Copies**—Folder describes a machine for making photo copies of anything written, typed, printed, drawn, or photographed, made in a few minutes right in your own department. American Photocopy Equipment Co.

52 **Method for Welding Cast Iron**—The quick and economical repair of broken or cracked engine blocks, V-belt pulleys, cylinder heads and other parts is described in new folder on Castolin low temperature welding. Gives properties of Castolin alloy rods for cast iron, alloy steel, aluminum, brass, bronze, etc. Eutectic Welding Alloys Co.



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Stoker Manufacturers Make Postwar Plans

ORGANIZATION of a Postwar Planning Committee for the stoker manufacturing industry was announced recently by J. M. McClintock, president of the Stoker Manufacturers' Assn. following the annual meeting of the Association's Executive Committee in Chicago recently. The stoker executive group unanimously approved the formation of this committee, the membership of which will consist of the chairmen of each of the Association's standing committees. In this way, every phase of the industry's problems as related to both the war effort and postwar plans will be taken into consideration. Mr. McClintock will head the new postwar stoker committee.

In making the announcement concerning this new committee, Mr. McClintock said: "The time appears to be approaching when our industry, in common with other sections of the heating industry and the coal industry, needs to seriously consider general and nation-wide problems which will be brought about when this country wins the war. Our postwar planning committee, representing every phase of the stoker industry, has already conferred with representatives of other industries as to postwar heating and fuel requirements. We are convinced that the 'battle of the fuels' will be renewed with greater intensity when the war is over and mechanical and automatic coal burning equipment manufacturers will be in the very thick of the struggle.

"Individual stoker manufacturers have their own postwar planning already cut out for them, but we have learned through years of experience—through good times and bad—through peace times and war—that cooperative, constructive and aggressive planning by the industry, pays dividends in more ways than one. Government agencies by the score are giving great consideration to postwar plans in housing, heating, city planning, and other phases involving every feature of American economic life, and industry must do its own planning and act accordingly or it will suffer from Government competition in many forms in postwar years."

The new stoker planning committee will meet shortly to outline specific plans and projects which can be properly undertaken by such an industry group, Mr. McClintock added. In the meantime, representatives of the Association and members of the new committee will attend a postwar plans-heating meeting in Cleveland, Ohio, next week sponsored by the National Warm Air Heating and Air Conditioning Association.

At the Association's recent Executive Committee meeting numerous other problems and subjects were considered. The resignation of Clifford M. Lewis, formerly sales manager of the Anchor Stove and Range Company, Louisville, Kentucky, as a member of the Executive Committee, was accepted. Mr. Lewis served on the committee for two years and took a prominent part in stoker industry affairs.

The committee also reviewed the situation as to stoker manufacturing and the problems and possibilities for increasing the production of commercial and industrial machines in 1943. Mr. McClintock stated that the next meeting of the Stoker Industry Advisory Committee organized under the authority of the War Production Board would not likely be held until after May 1st. Such meetings are called by the War Production Board and consider only problems related directly to the war effort involving stoker production, WPB regulations, fuel supplies, and manufacturing and material "bottlenecks."

The Executive Committee of the stoker organization also authorized the calling of an annual meeting in June at a place and exact date yet to be determined. In reality, this will be the stoker industry's second annual war conference for attendance is limited to executive members of the Association and subjects considered must be directly or indirectly related to the nation's war effort.

Minnesota Proposes Federal Hydroelectric Power Plant

A resolution has been offered in the State Legislature, St. Paul, Minn., requesting the Federal Government to develop a hydroelectric power project on the St. Croix River, in the territory between St. Paul and Minneapolis, and the head of the Great Lakes. It is set forth in the resolution that a power dam could be constructed at economical cost to provide a head of about 80 ft., creating an artificial lake of approximately 35 miles length for reservoir service. The proposed generating station is indicated to have a rated capacity of about 64,000-hp., and would furnish power supply in an area that is said to require electric service.

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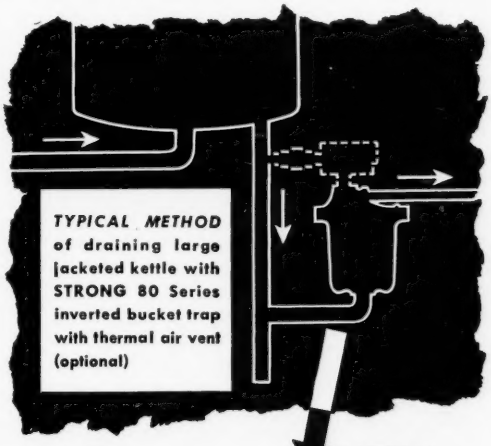
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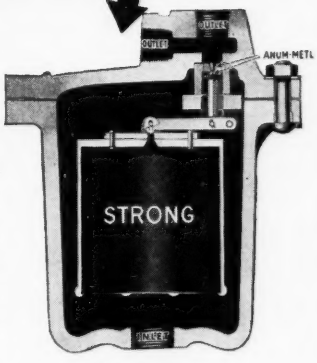

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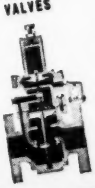

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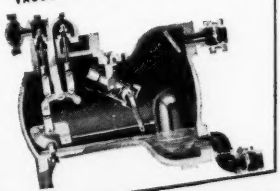

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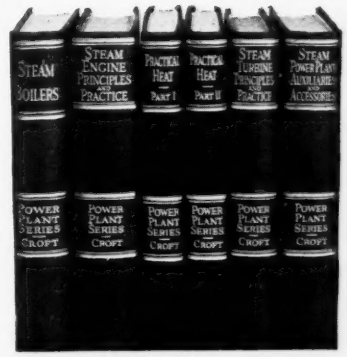
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NEW ENGINEERING BOOKS

Alternating-Current Machines. By A. F. Puchstein and T. C. Lloyd. Second edition, size, 6 by 9 in., 655 pp, cloth, illustrated. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York, N. Y., 1942. Price $5.50.

It would be difficult to find between the covers of a single book a more comprehensive treatment of the subject of alternating-current machines than is to be found in this volume by Puchstein and Lloyd. Although it is designed as a textbook for use in teaching electrical engineering students it should be very useful to the practicing engineer in the field. It covers all types of alternating-current machines, including mercury-vapor rectifiers and deals with each type of machine in turn in a manner which makes it easy to refer to specific phases of any type. Each subject is treated in the following order: 1 Construction; 2 Discussion of operating characteristics; 3 Calculation of operating characteristics from tests, and 4 Discussion and analyses of various related phenomena.

As pointed out by the authors, the amount of time devoted to the subject of alternating-current machines varies widely in college courses. Since courses are usually built around a textbook, the length and thoroughness of the textbook are of great importance. Hence, the authors believe that it is desirable to place as thorough a book as possible in the hands of the student even though it may not be possible to cover more than a fraction of the material in it, in the class room. The problem of deciding what can be omitted in a college course has been simplified by the arrangement of the material, referred to in the preceding paragraph.

The order of presentation of the material is as follows: 1 Synchronous generators; 2 Transformers; 3 Polyphase induction motors; 4 Single-phase induction motors; 5 Synchronous motors; 6 Alternators in parallel; 7 Synchronous converters; 8 Mercury-vapor rectifiers; 9 Series motors; 10 Repulsion motors.

In general, the scope and character of this book have not been changed since the publication of the first edition six years ago. Only the steady-state phenomena have been covered, with the exception of the analysis of hunting under various conditions of synchronous-motor operation.

During the six years since the first edition, however, a number of methods of analysis pertaining to alternating current machines have come into general use. Notable among them have been the new methods of calculating alternator regulation and the concepts of direct- and quadrature-axis synchronous motors have been rather completely rewritten to include such theory.

The authors have both had wide experience in both the educational field and in industry. Mr. Puchstein is consulting engineer for the Celanese Corporation of America and was formerly Associate professor of electrical engineering at the Ohio State University. T. C. Lloyd is Chief engineer of Robbins and Meyers, Inc., and was formerly Associate professor of electrical engineering at Antioch College.

The Theory and Practice of Heat Engines. By R. H. Grundy. First edition. Size 5½ by 8½ in., 723 pp, cloth, illustrated. Published by Longmans, Green and Co., New York, N. Y., 1942. Price $6.25.

This book presents an outline of the practice of Heat Engines and the accompanying theory from which an easy step may be made to more specialized books. As the author indicates, while a large number of books have been written on the subject of Heat Engines, with each new development it becomes increasingly difficult to confine the subject within the covers of one volume. Accordingly it has been the author's aim to present a book simple enough to cover the entire practical side of the subject and at the same time to condition the student to the use of more advanced and specialized books. A simple method has been adopted to distinguish between the elementary and more advance sections of the work. Those parts intended for more advance study are marked with double asterisks and should be omitted at the first reading.

In some respects the method of presentation is unique, due to the fact that the author felt it necessary to fill the gap left by the usual textbooks, which deal either fully with theory, and neglect practice, or vice versa. An up-to-date treatment of the theory is given from first principles in Part I, and its dependence upon physics and chemistry

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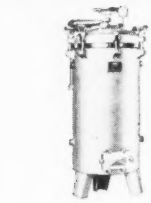

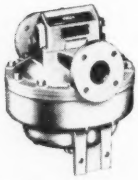

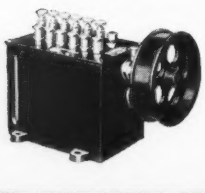

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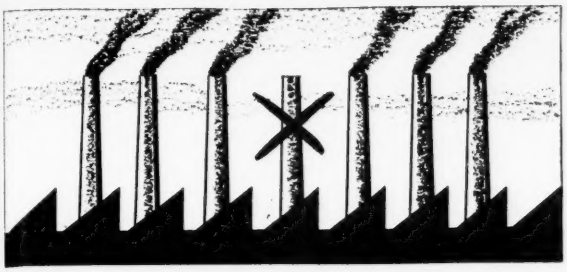

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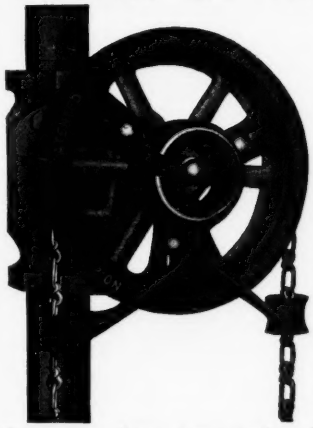

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has been emphasized by introducing certain elementary work which would not ordinarily be included in a book of this kind. This, however, adds to the value of the book for reference purposes.

The practical side of heat engines, including steam engines and turbines, and internal combustion engines, has been dealt with in Part II.

The continuity of the subject is preserved throughout, even to the extent of placing illustrative examples at the end of the chapters. While descriptions of the latest plant equipment is included with sectional views and photographs, the historical side of the subject has not been neglected.

The first part, that devoted to "theory" occupies approximately 400 pages. Part II, devoted to "practice" takes up slightly over 300 pages. At the end of the volume are five appendices covering subjects which aid in understanding the book proper.

Transients in Linear Systems. Vol. 1. By Murray F. Gardner and John L. Barnes. First edition. Size 6 by 9 in., 389 pp, cloth. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York, N. Y., 1942. Price $5.00.

This book evolved from a set of lecture notes used in a one-semester course offered to beginning graduate students in electrical and mechanical engineering at the Massachusetts Institute of Technology. Primarily, the book is intended for first-year graduate work in electrical and mechanical engineering. Secondarily, it can be used for graduate work in mathematical physics and applied mathematics, and it should also serve as a reference for practicing electrical and mechanical engineers and industrial physicists.

The work appears in two volumes, the material being divided into separate parts on one- and multidimensional problems. Invariant systems having lumped parameters, leading to ordinary integrodifferential equations and difference equations are treated in the present volume (Vol. 1) while those having distributed parameters, leading to partial integrodifferential equations are treated in volume 2, now in preparation.

In volume 1 the discussion progresses by easy stages. Emphasis is placed upon a systematic presentation of the method of setting up physical problems in mathematical form. The mathematical procedure for solving problems is based on an extensive table of operation- and function- transform pairs which is derived and used much the same way as ordinary tables of integrals. A comparison is given of the Fourier- and the Laplace-transformation methods.

It will be obvious that this book requires a certain background of knowledge but to those who have that background it should be of considerable value. Many of the illustrative examples, of which an ample supply is presented in detail, and the practice problems given at the end of each chapter have definite engineering background. They have been selected from a wide variety of topics ranging from surge generator transients to television synchronizing impulses and to the behavior of a rotary stabilizer in a motion picture film head.

Murray F. Gardner is Associate professor of Electrical Engineering at the Massachusetts Institute of Technology and John L. Barnes is Professor of Mathematics and Chairman of the Department of Applied Mathematics at Tufts College.

Welding Handbook. 1942 edition. Size 6 by 9 in., 1593 pp, cloth. Published by the American Welding Society, 33 W. 39th St., New York, N. Y., 1942. Price $6.00, in the U.S.A., $6.50 elsewhere.

This, the second edition of the Welding Handbook of the American Welding Society, has been compiled in response to a demand for general up-to-date information, in concise form, on the subject of welding. With the growing importance of welding as a war production and industrial tool in the construction of ships, tanks, planes, armament, etc., this book should prove of great value to many people. The work represents the work of 270 leading welding experts and the information presented is authentic and timely.

In order to serve its purpose best, the book has been prepared to cover, first, the physics and metallurgy of welding and the weldability of steels; second, the welding and allied processes; third, the materials used; fourth, training, inspection and safety; fifth, design considerations and the testing of welding; and sixth, the application of welding.

The text has been generally arranged in handbook style. Nevertheless, the material has been arranged in a logical sequence with enough explanatory matter so that the book may be used as a textbook in engineering schools and as a reference in trade

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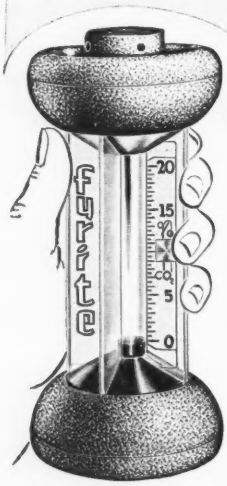

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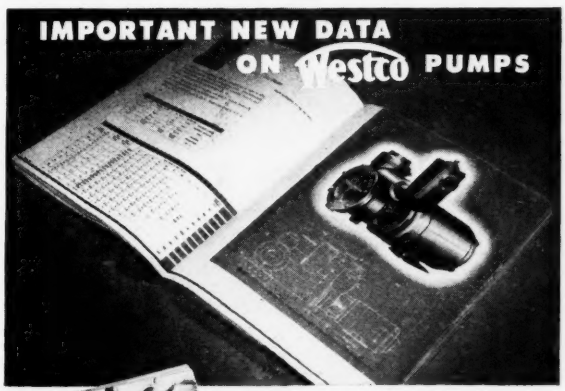

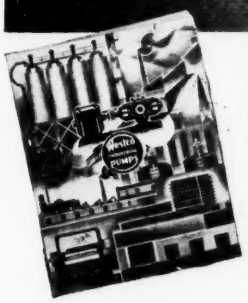

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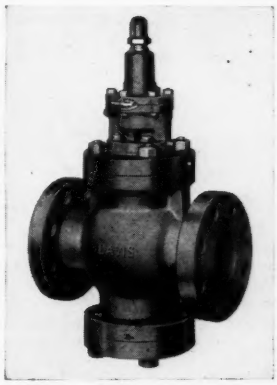

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schools. The primary purpose of the volume, however, is to give engineers and operators an authoritative reference book on the technical phases of welding. It should contain the answers to many questions that are bound to come up in connection with welding problems in various industries.

Marine Engineering. By J. M. Labberton. First edition. Size 6 by 9 in., 437 pp, cloth. Published by McGraw-Hill Book Co., 330 W. 42nd St., New York, N. Y., 1943. Price, $4.00.

This book on marine engineering is intended primarily for engineers who have had some basic training in electrical and mechanical engineering or for anyone who has a good knowledge of engineering fundamentals. It is an up-to-date book; the old time marine engineer, temperamentally addicted to the use of triple or quadruple expansion reciprocating engines would probably find little in it of interest for engines are scarcely mentioned. It does, however, contain excellent data on turbines; at the end there is a short chapter dealing with Diesel ships.

Logically enough, this book begins with a consideration of hull design and resistance. Since the hull of a ship moving through the water constitutes the "load" with which the marine engineer has to deal, it is natural that he should know something about the characteristics of hulls and their effect upon power consumption. The first chapter on hull design is followed by two excellent chapters, one on propellers and the other on propeller shafting. Then in order come chapters on reduction gears, marine fuels and combustion, boilers and steam generators and then a chapter on turbines. These are followed by chapters on marine pumps, heat exchangers, forced draft and duct work, marine electrical engineering, refrigeration, feed systems, heat balance, the Diesel ship, layout, astern operation, electric drive, naval vessels and finally, ship's trials.

The author is a Lieutenant Commander in the U. S. Naval Reserve, and as he points out in the preface, much of the contents of the book was derived from long and pleasant conversations with successful marine engineers of varied experience.

The material in the book has been presented almost in its entirety by the author in lectures on marine engineering in the Graduate Division of the College of Engineering of New York University and has been curtailed and amplified from time to time as indicated by the reactions of the students. Also, much of the material has been presented in lectures in war training courses to electrical- and mechanical-engineering graduates working in the engineering departments of ship and Navy yards. The reception accorded these lectures by the students indicated that the material was what they needed and wanted.

Another point of interest regarding the mathematical calculations, all the calculations given in the book were performed on a 10-in. slide rule, so that degree of accuracy can be expected. On the whole it is a very good book, well worth the study of those interested in modern marine engineering.

Industrial Radiology. Second Edition. By Ancel St. John and Herbert R. Isenburger. Size 6 by 9 in, 298 pp, cloth binding. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York City. Price $4.00.

Since the appearance of the first edition of this book nine years ago, so much material has been accumulated that this present revision seemed necessary. The change from the title of the original book, Industrial Radiography, to *Industrial Radiology*, which includes both radiography and fluoroscopy, indicates the fact that visual inspection of materials has now come of age.

In preparing this new edition the authors have attempted to present the practical aspects of industrial radiology in a form and language which can be understood by students, laymen and engineers who desire to obtain some useful knowledge of the basic theories involved. No attempt is made to produce a scientific treatise or a comprehensive work of all the theories. It is the purpose of the book to help workers in this field to perform their investigations or inspections more easily, to stimulate teaching and study of industrial radiology in technical schools, and to direct the attention of engineers and others to the potential value of this new technique in activities where heretofore its use has not been fully realized.

The book is divided into 21 chapters and contains many photographs and illustrations. In the back are four appendices covering radiographic rules, tables, charts and bibliographies and a master index to make all the applications and possibilities of Industrial Radiology available for reference without enlarging the text unduly.

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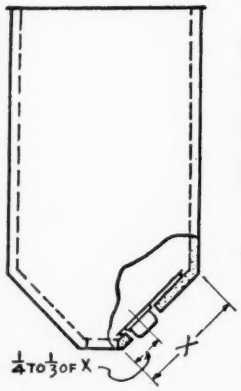

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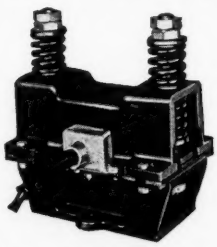

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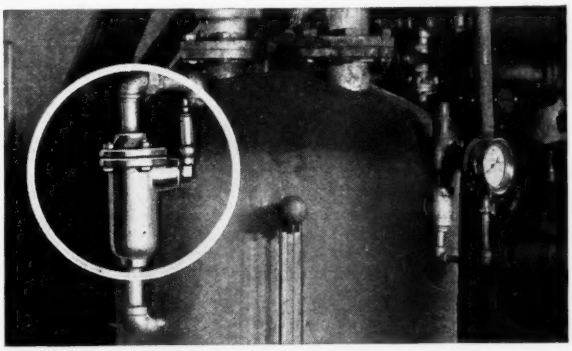

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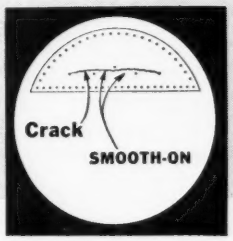

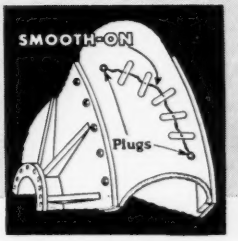

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Power Plant Construction News

Calif., Los Angeles — Consolidated Steel Co., Ltd., Shipbuilding Division, Berth 136, Wilmington harbor district, has approved plans for new one-story generator and compressor plant at yards, reported to cost over $75,000, with equipment. Work is scheduled to begin at once.

Colo., Denver—Stay-Put Form & Clamp Co., manufacturer of mechanical specialties, care of C. Francis Pillsbury, Midland Savings Building, Denver, architect, plans installation of electric power equipment in new one-story plant at York and 40th Sts., for which super-structure will begin at early date. It will be about 75 x 200 ft. estimated to cost in excess of $75,000, including machinery.

Colo., Pueblo—Colorado Fuel & Iron Corp., Continental Oil Bldg., Denver, Colo., plans installation of electric power equipment in connection with expansion program at steel mill at Pueblo, for production for Government. Work will include several new mill units. Also a new steam-generating station and battery of about 74 coke ovens. Entire project will cost about $5,500,000, with financing provided by Defense Plant Corp., Washington, D. C., Federal agency.

Conn., Bridgeport—Board of County Commissioners, Bridgeport, has plans for conversion of power house from oil to coal fuel, including installation of stokers and other equipment. Plant is used for central-heating service for County Court House and other county buildings. No estimate of cost announced. Fletcher-Thompson, Inc., 211 State St., Bridgeport, is consulting engineer.

Conn., Greenwich—Agricultural Committee of Chamber of Commerce, Noel Armstrong, chairman, Greenwich, is at head of a project to construct and operate a new cold storage and refrigerating plant on Mason St., near Bruce Park Ave., with locker system of about 500 units. Cost reported over $70,000, with equipment.

Ill., Moline—Deere & Co., Moline, manufacturer of agricultural and farming machinery, plans installation of electric power equipment in connection with expansion program at plant for production for Government, consisting of new building and installation of machinery for increased capacity. Cost about $500,000, with financing by Defense Plant Corp., Washington, D. C., Federal agency.

Ind., Vincennes—Baltic Mills, Inc., manufacturer of flour, corn meal, etc., plans installation of electric power equipment in connection with proposed rebuilding of portion of mill, recently destroyed by fire, with loss reported close to $100,000, including machinery.

Indiana—Tubular Alloy Steel Corp., 71 Broadway, New York, N. Y., plans installation of electric power equipment in connection with expansion in a plant in Indiana, exact location not announced comprising additional buildings and installation of machinery for increased output for Government. Entire project will cost about $930,000, with financing provided by Defense Plant Corp., Washington, D. C., Federal agency.

Md., Baltimore—Chemical & Pigment Co., 6401 South Helena Ave., manufacturer of industrial chemicals, etc., plans early construction of new steam power house at plant, reported to cost about $50,000, including equipment. Osborn Engineering Co., 7016 Euclid Ave., Cleveland, Ohio, is consulting engineer.

Nebraska—War Department, Washington, D. C., has authorized expansion in air force base in Sarpy County, exact location withheld, including hangars, shops, storage and distributing buildings, and miscellaneous structures. Electric power equipment will be installed. Also, will make extensions in electrical distribution system and service facilities. Entire program will cost approximately $2 000,000, and will be carried out under direction of U.S. Engineer Office, Omaha, Neb.

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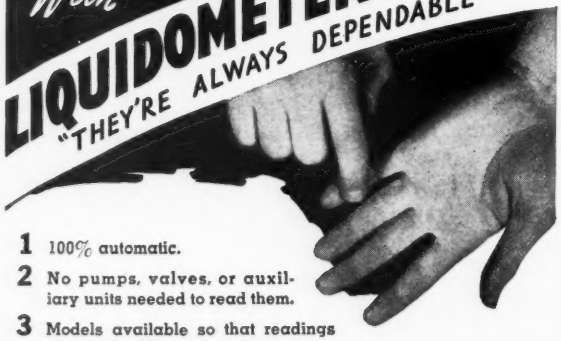

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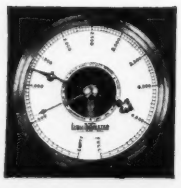

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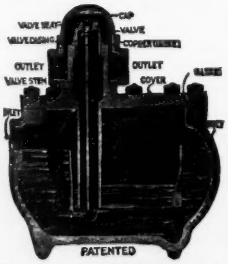

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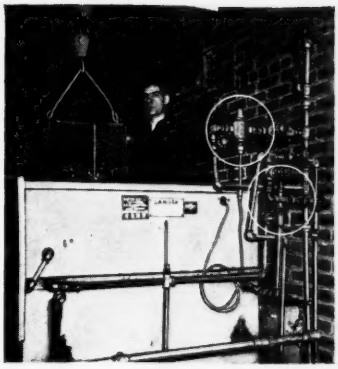

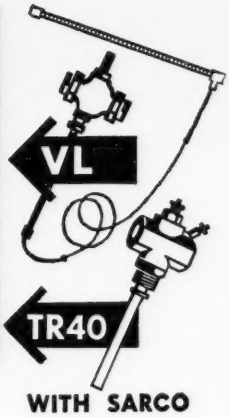

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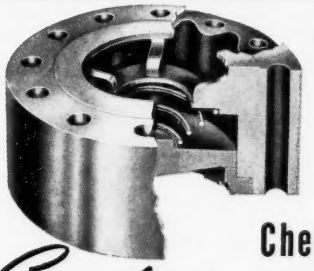

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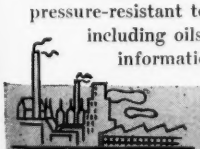

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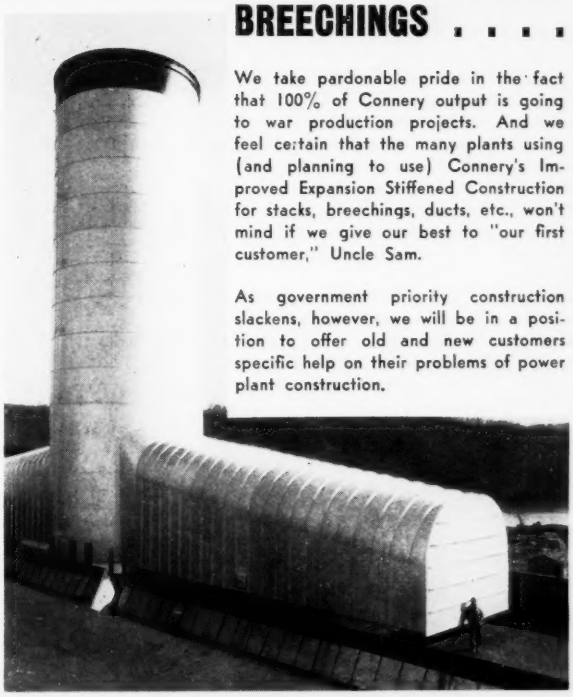

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N. Y., Syracuse—Doyle Machine & Tool Corp., 320 West Taylor St., manufacturer of aircraft accessories, plans installation of electric power equipment in connection with expansion in plant for production for Government. Work will be carried out soon. Cost estimated about $200,000, with financing by Defense Plant Corp., Washington, D. C.

New York—E. I. duPont deNemours & Co., Inc., duPont Building, Wilmington, Del., manufacturer of chemicals, explosives, plastics, etc., plans two large plants in New York and Virginia, respectively, exact locations not announced, for manufacture of certain war products for Government. Each will comprise several buildings, equipped for heavy output. Electric power equipment will be installed; boiler houses are planned. Entire project will cost about $4,400,000, with financing by Defense Plant Corp., Washington, D. C., Federal agency.

Ore., Roseburg — Western Battery Separator Co., Marshfield, Ore., manufacturer of electric storage batteries, parts, etc., plans installation of electric power equipment in new one-story plant at Roseburg, where tract of land has been acquired. Cost reported over $85,000, with machinery. It is understood that a priority rating will be secured. Main offices of company are at 277 Pine St., San Francisco, Calif.

Pa., Scottdale—Duraloy Co., manufacturer of steel alloy pipe, tubing, castings, etc., plans installation of electric power equipment in connection with expansion in plant for production for Government. Entire project will cost about $350,000, with financing by Defense Plant Corp., Washington, D. C., Federal agency. Proposed to carry out work soon.

S. C., Spartanburg — Spartanburg County Farmers' Market Board has plans for new one-story cold storage and refrigerating plant on local site, reported to cost close to $45,000, with equipment. Proposed to begin erection soon. J. B. McCrary Co., 22 Marietta St., Building, Atlanta, Ga., is consulting engineer.

South Dakota—War Department, Washington, D. C., has approved plans for expansion in air force base in Pennington County, exact location withheld, including hangars, shops, storage and distributing buildinsg and other structures. Electric power equipment will be installed. Also, will make extensions in electrical distribution lines and service facilities. Entire development will cost over $3,000,000, and will be in charge of U. S. District Engineer Office, Fort Peck, Mont.

Tenn., Memphis—Southern United Ice Co., 308 Court St., C. E. Wright, head, has plans under way for new ice-manufacturing and cold storage plant. Cost reported over $45,000, with equipment. C. P. Tucker, 800 Forrest St. N. W., Atlanta, Ga., is consulting engineer.

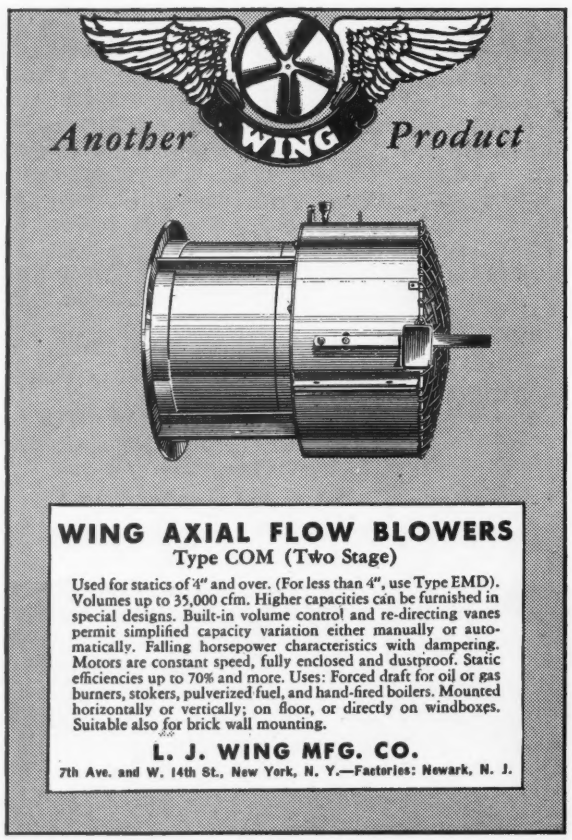
Utah, Marysvale — Kalunite, Inc., 600 West 33rd St. South, Salt Lake City, Utah, plans installation of electrical and mechanical equipment in connection with expansion in processing plant in vicinity of Marysvale, used for extraction of alumina from alunite. Also will increase power facilities at mill. Entire project will cost about $900,000, with financing by Defense Plant Corp., Washington, D. C., Federal agency.

Wash., Brewster—Brewster Cooperative Growers, Inc., plans extensions in cold storage and refrigerating plant, with installation of additional equipment, belt conveyors and other facilities, in connection with new one-story addition, 70 x 180 ft, to fruit-packing plant. Entire project is reported to cost over $50,000, with machinery.

W. Va., Martinsburg—Explosive Products Corp., Washington Building, Washington, D. C., plans a power plant for light, power and central-heating service in connection with a housing development at plant in vicinity of Martinsburg. Entire project will comprise about 16 housing structures, with hospital, and is reported to cost close to $1,750,000. Workmen's Housing Corp., 2000 West 25th St., Cleveland, Ohio, is architect and engineer.

Wis., Oconto—Arthur Mallien, Stiles, Wis., has acquired an industrial building at Oconto, and will remodel and equip for new cold storage and refrigerating plant, with locker system comprising about 300 units. Latter division will be increased at later date. Cost reported over $50,000 with equipment.

Wis., Watertown—Cambia Canning Co., manufacturer of canned food specialties, plans one-story addition to boiler house, with installation of additional equipment for increased capacity. No estimate of cost announced. Arthur Kuenzi, 202 North Water St., Watertown, is engineer.



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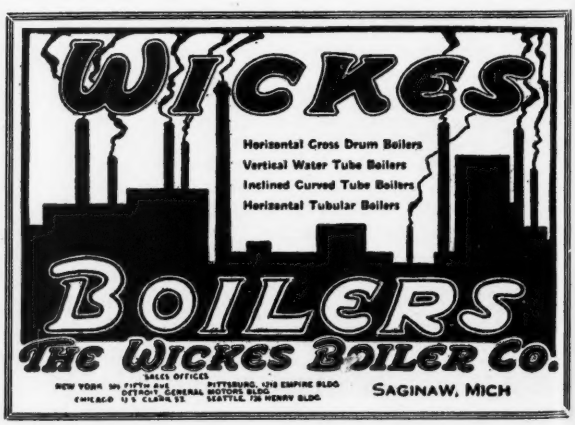

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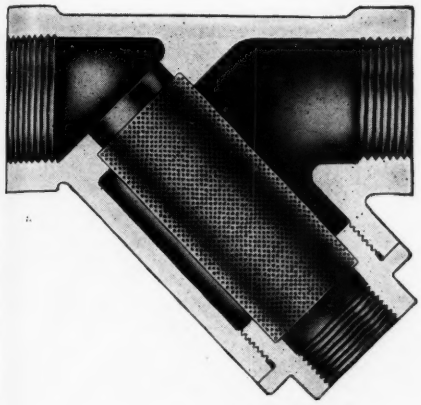

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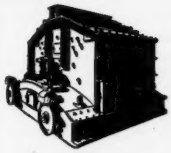

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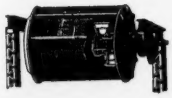

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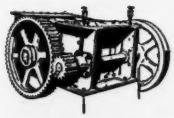

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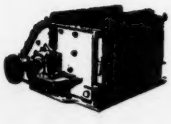

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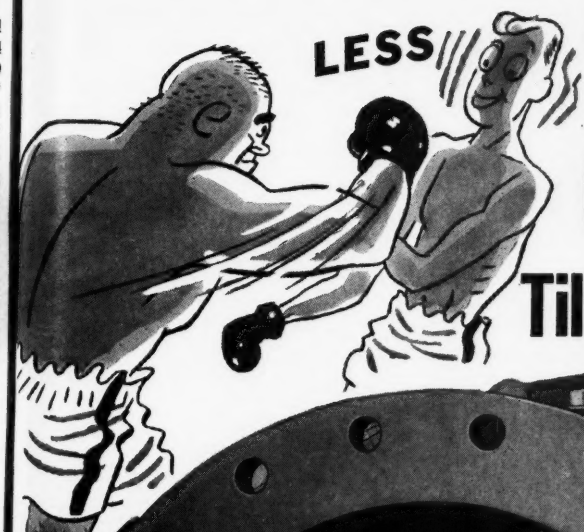

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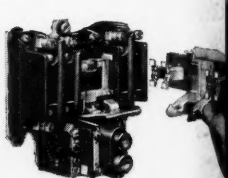
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